National Aeronautics and
Space Administration

**Office of Human Resources
and Education**
Education Division

Educational Program	
Students	University

1997 Graduate Student Researchers Program

On the Cover

Image of Western Hemisphere as taken by GOES 8 meteorological satellite in September 1994.
(Pictured top left)

The Eagle Nebula was photographed by Jeff Hester and Paul Scowen of Arizona State University using the Wide Field and Planetary Camera 2 on board NASA's Hubble Space Telescope on April 1, 1995.
(Pictured top right)

STS-73 Onboard View ------ This view gives an overall perspective of the working environment of the astronaut. At work in support of the U.S. Microgravity Laboratory mission in this particular scene are astronaut Catherine G. Coleman, who busies herself at the glovebox, and payload specialist Fred W. Leslie, monitoring the Surface-Tension-Driven Convection Experiment. (Pictured bottom left)

F-15 Active Takes F-18 Along ----- The twin-engine F-15 is equipped with new Pratt & Whitney nozzles that can turn up to 20 degrees in any direction, giving the aircraft thrust control in the pitch (up and down) and yaw (left and right) directions. On March 27, 1996, NASA began flight testing a new thrust-vectoring concept on the F-15 research aircraft to improve performance and aircraft control. The new concept should lead to significant increases in performance of both civil and military aircraft flying at subsonic and supersonic speeds. NASA Pilot, Rogers Smith and Photographer, Carla Thomas, fly the F-18 chase to accompany the flight. (Pictured bottom right)

"Our greatest strength is our workforce. We aggressively build a team of highly qualified individuals that is representative, at all levels of America's diversity. We foster a culture that is built on trust, respect, teamwork, communication, empowerment, and commitment in an environment that is free of discrimination."

NASA Strategic Plan,
February 1996

1997 NASA Graduate Student Researchers Program

NASA Headquarters
Office of Human Resources
and Education
Education Division
Washington, DC 20546

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Introduction

The Graduate Student Researchers Program (GSRP)

The future of the United States is in the classrooms of America and tomorrow's scientific and technological capabilities which are derived from today's investments in research. In 1980, NASA initiated the Graduate Student Researchers Program (GSRP) to cultivate additional research ties to the academic community and to support a culturally diverse group of students pursuing advanced degrees in science and engineering.

Students from traditionally underrepresented groups (African Americans, Native Americans, Alaskan Natives, Mexican Americans, Puerto Ricans, Native Pacific Islanders, women, and persons with disabilities) are strongly urged to apply. No applicant shall be denied consideration or appointment in the GSRP on the grounds of race, creed, color, national origin, age, sex, or disability.

Fellowships, of up to $22,000, are awarded for one year and are renewable, based on satisfactory progress and available funding, for a total of three years. Approximately 400 graduate students are supported by this program each year. Students may apply at any time during their graduate career or prior to receiving their baccalaureate degree. An applicant must be sponsored by his/her graduate department chair or faculty advisor. Other eligibility requirements are described in the "Administrative Procedures" section.

Each year approximately 150 new awardees are selected based on competitive evaluation of their proposal and academic qualifications. Usually sixty of the 150 new awards each year are sponsored by NASA Headquarters — through the Office of Space Science (OSS), the Office of Life and Microgravity Sciences and Applications (OLMSA), and the Office of Mission to Planet Earth (MTPE) — in the fields of structure/evolution of the universe, origins/planetary systems, solar system exploration, Sun-Earth connection, information systems, microgravity science and applications, life sciences, and Earth sciences.

Students applying for these fellowships are competitively evaluated on their academic qualifications, proposed research, and plan of study by NASA's discipline scientists. Fellows selected by NASA Headquarters conduct research at their respective institutions.

The remaining awards are distributed through NASA's Field Centers, each of which has specific research programs and facilities. Fellows selected by Centers must spend some period of time in residence at the Center, taking advantage of the unique research facilities of the installation and working with Center personnel. The projected use of Center expertise and facilities is an important factor, along with academic qualifications and research plans, in the selection of Center fellows.

Students applying for a Center fellowship are strongly urged to contact the relevant NASA Program Administrator prior to developing a proposal.

U.S. citizens who have been accepted as graduate students at an accredited U.S. college or university are eligible for awards in this program.

The application deadline is February 1, 1997 with award notification in early May 1997.

Administrative Procedures

Submission of Proposal
All applicants must submit one original and five (5) copies of all materials by **February 1, 1997,** to the appropriate NASA facility from which consideration is being requested. Submissions should be addressed to the attention of the appropriate Program Administrator listed on page 5 of this brochure.

Applications will be reviewed and selections made in early May 1997. Proposed starting dates for new awards must be between July 1, 1997 and October 1, 1997.

Renewal Applications
Proposals for renewal are to be submitted to the appropriate Installation address by the **February 1 deadline**. All applicants should submit an original and two (2) copies of all materials. The proposal for renewal **must** include a signed original proposal cover sheet, budget page, university certification, as well as a statement (approximately one to two pages) by the student outlining his or her progress on the research or plan of study. A transcript of the student's grades during the preceding year and a one-page evaluation and recommendation for renewal signed by the faculty advisor must also be included. Proposals **will not** be renewed without this information. The starting date for renewals should be on the anniversary of the original grant.

Selection of Proposals
Graduate students are selected for participation in this program by NASA Headquarters, individual NASA Field Centers, or by the Jet Propulsion Laboratory. Selection is based on:

(a) the quality of the proposed research or plan of study and its relevance to NASA programs;
(b) student academic qualifications;
(c) the ability of the student to accomplish the defined research; (for Center applicants); and
(d) the proposed utilization of Center research facilities.

Awards
Fellowships are made for a period of one year and may be renewed annually for a total of three years. Fellowship renewal is based on satisfactory progress as reflected in performance evaluations. Renewals must also be approved by NASA Field Center Program Administrator and Technical Advisor at the appropriate NASA Field Center or NASA Headquarters.

Eligibility
Full-time (as defined by the university) graduate students enrolled in an accredited U.S. college or university are the only persons eligible for program awards. They must be citizens of the U.S. Students may enter the program at any time during their graduate work or may apply prior to receiving their baccalaureate degrees. Students who apply prior to acceptance in graduate school must submit a list of prospective schools and if selected must provide proof of acceptance prior to an award. All applications must be sponsored by the student's graduate department chair or faculty advisor. An individual accepting this award may not concurrently receive other Federal fellowships or traineeships. African Americans, Native Americans, Mexican Americans, Puerto Ricans, Alaskan Natives, Native Pacific Islanders, women, and persons with disabilities are strongly urged to apply.

Equal Opportunity
No applicant shall be denied consideration or appointment as a NASA Graduate Student Researcher on the grounds of race, creed, color, national origin, age, sex or disability.

Equipment
The use of training grant funds for the purchase of equipment is prohibited.

Funding
The total annual award per graduate student cannot exceed $22,000. This amount includes a $16,000 (maximum) student stipend and an allowance of up to $6,000 consisting of $3,000 for student expenses and $3,000 for university expenses. The student allowance may be used to help defray tuition costs, purchase books and software, or to provide per diem and travel for the student. It may also be used to help defray living expenses during periods of Center residency.

The university allowance may also be used for tuition or to support research-related travel for the faculty advisor or the student. Alternative uses for this allowance may be requested but must be consistent with the intent of the program.

New grant applicants attending GSRP workshops/symposiums prior to their grant start date may be reimbursed for travel expenses.

Disposition of Unused Funds
If a student ends the GSRP earlier than anticipated, the student stipend

is prorated and terminated. Any unused student/university allowances are returned to NASA. If a student withdraws within the first quarter of the award year, the award will be prorated and the remaining funds deobligated. Renewal applicants who have funds remaining from their previous year's budget may carry the remaining funds over into the following program year.

Obligation to the Government
A student receiving support under the Graduate Student Researchers Program does not incur any formal obligation to the Government of the United States. The objectives of this program will be served best if the student actively pursues research, teaching, or employment in aeronautics, space science, or space technology after completion of graduate studies.

Replacement Student
If a student discontinues participation in the program, the university may nominate another student with similar achievement and research objectives to complete the remaining months of the current grant year. If the nominated replacement student is approved, an amendment to the grant will be issued modifying the name of the participating student. Replacement students must be approved by the appropriate NASA Grants Office.

Replacement students electing to apply to the GSRP for the following program year are not automatically entitled to an award, and are subject to the evaluation and selection procedures administered to new applicants. Replacement students, selected as new applicants will be eligible for up to three full years of support, depending upon satisfactory progress and available funding.

Documentation required for nomination of replacement students must include a written statement by the original student giving the date and reason for withdrawal from the program. A proposal cover sheet signed by the replacement student and faculty advisor, and a brief description of the student's research investigation and educational background are also required.

Foreign Travel
All foreign travel, charged to the grant, must clearly be relevant to the research effort and must have prior approval of the appropriate GSRP Administrator and NASA Grants Officer. For each foreign trip, the student or advisor must submit a written request on university letterhead stating the purpose, costs, travel dates, and the NASA fellowship number.

Internal Revenue Service
All questions concerning taxes should be directed to the Internal Revenue Service. Refer to IRS Publication 520 titled “Scholarships and Fellowships,” and Publication 508 titled “Educational Expenses.”

Inquiries
Questions concerning the preparation and submission of proposals and the administration of this program are to be directed to the appropriate Program Administrator.

Student Evaluation Forms
Students completing their last year in the program will be mailed an evaluation form 60 days prior to termination date. These forms must be completed and returned to the appropriate NASA Program Administrator. Students with approved no-cost extensions should return completed forms at the time of fellowship termination. If you do not receive the evaluation form, contact the appropriate Program Administrator.
NOTE: This form is not intended to be used in lieu of the final administrative report.

Final Administrative Report
It is the responsibility of the institution receiving a NASA fellowship grant to ensure the final report on the fellow's research and academic progress is submitted. This report is due no later than 90 days after the termination date of the award. The report must include: the degree granted; important results of the student experiences (e.g., thesis title, papers published other than thesis, presentations made, awards, honors); and employment or other future plans. This report should be submitted to the appropriate NASA Center or Program Office GSRP Administrator, and the relevant grants office. NASA Graduate Student Researchers fellowships are subject to the provisions of 14 CFR 1265, Government-wide Debarment and Suspension.

Preparation of Proposal

The application forms enclosed in this brochure must be accompanied by the items listed below.

Proposal Requirements
Proposals for the GSRP must be written by the student. To ensure the preparation of a competitive proposal, students are strongly encouraged to collaborate with a faculty member and with a potential NASA Technical Advisor to identify a project. Further, students are advised to enlist the aid of their faculty advisor for guidance, review, and commentary on the written material prior to submission. All applicants must submit one original and five (5) copies of all materials by **February 1, 1997,** <u>to each Center/Program Office for which consideration is sought</u>.

At least one (1) complete proposal package must contain original signatures. Proposals must be assembled in the following order:

1) Original Signed Proposal Cover Sheet
2) Abstract (100 words)
3) Budget
4) Description of Proposed Research and/or Plan of Study
5) Letter of Recommendation
6) Personnel
7) Certification for Debarment Suspension and Drug Free Workplace
8) Planned Use of Facilities and Resources (Center Applications Only)

The original and all copies of proposals must be stapled. To facilitate the recycling of proposals after review, proposals should be submitted on plain, white paper only. Do not use cardboard stock, plastic covers, spiral binders, colored paper, etc.

1. Proposal Cover Sheet
The proposal cover sheet must be filled out and signed by the student, faculty advisor, and university official responsible for committing the institution for sponsored research. Proposals will not be funded without the required university approval signatures.

2. Abstract
Proposal abstracts should concisely detail the intended research and its relationship to the NASA mission. The abstract should not exceed 100 words.

3. Budget
A twelve-month budget must include the following:
(a) student stipend — up to $16,000 basic stipend for twelve months;
(b) student allowance — $3,000. Cost estimates for tuition expenses and/or anticipated travel and living expenses for the student at a NASA facility; and
(c) university allowance — $3,000. Cost estimates for travel of faculty advisor, or other expenses that relate to the student's research project. Student tuition may also be charged against this allowance. The budget must be prorated when the student anticipates less than a 12 month program tenure.

4. Description of Proposed Research and/or Plan of Study
Students must prepare a typed, detailed research proposal (not to exceed five single-spaced pages). At a minimum, this critical document must contain a research plan, study objectives, schedule, methodology, key elements, and milestones.

5. Letter of Recommendation
The faculty advisor must prepare and sign a one page letter of recommendation on behalf of the student.

6. Personnel
The faculty advisor must submit a short biographical sketch that includes name, current position, title, department, university address, phone number, and principal publications. The student is required to submit an official transcript of grades with university seal affixed to at least 1 copy and a summary of education, along with special training, previous research projects awards, scholarships, significant accomplishments, and any other relevant information.

7. Certifications
All application packages must include university certifications to debarment and suspension and drug-free workplace.

8. Facilities and Resources (Center Applicants Only) Students competing for center awards must indicate the NASA facilities and resources to be used in support of the research and/or plan of study, including an estimate of any computer time required. Students are strongly encouraged to contact the appropriate NASA Technical Advisor to coordinate research activities.

Program Administrators

The NASA Graduate Student Researchers Program (GSRP) is managed at the national level by:

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NASA Headquarters Program Offices and each NASA Field Center administers its own GSRP program under the direction of the following officials. Please direct proposals and inquiries to these individuals:

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Summary of Research Areas

NASA Headquarters

Office of Space Science

- Astronomical Search for Origins and Planetary Systems
- Information Systems
- Solar System Exploration
- Structure and Evolution of the Universe
- Sun-Earth Connection

Office of Life and Microgravity Sciences and Applications

- Microgravity Science and Applications
- Life Sciences

Mission to Planet Earth

- Biochemical Dynamics
- Climate and Hydrologic Systems
- Data Information Systems
- Ecological Systems and Dynamics
- Human Interactions
- Solar Influences
- Solid Earth Processes

Ames Research Center

- Aeronautical Fluid Mechanics
- Aerothermal Material and Structures
- Aerothermodynamics
- Air Traffic Management
- Aircraft Conceptual Design
- Applied Computational Fluid Dynamics
- Applied Information Technology
- Artificial Intelligence
- Computational Chemistry
- Computational Fluid Dynamics Computer Vision
- Earth Atmospheric Chemistry and Dynamics
- Ecosystem Science
- Ecosystem Science and Technology
- Exobiology
- Experimental Aerodynamics
- Flight Research
- High Performance Computing and Communications (HPCC)/ Computational Aerosciences Project
- Human Factors
- Hypersonics
- Infrared Astronomy Projects and Technology Development
- Life Support
- Neuroengineering
- Neurosciences
- Rotocraft Aeromechanics
- Scientific Visualization and Interactive Computer Graphics
- Solar System Exploration
- Space Biology
- Space Physiology
- Space Technology
- Theoretical Astrophysics
- Turbulence Physics

Hugh L. Dryden Flight Research Center

- Advanced Digital Flight Control
- Aircraft Automation
- Flight Dynamics
- Flight Systems
- Flight Test Measurements and Instrumentation
- Fluid Mechanics and Physics
- Integrated Test Systems and Aircraft Simulation
- Propulsion/Performance
- Structural Dynamics

Goddard Space Flight Center

- Aircraft Program
- Atmospheric Chemistry and Dynamics Branch
- Atmospheric Experiment Branch
- Balloon Program
- Biogeochemical Cycles
- Biospheric Studies
- Causes of Long-Term Climate Change
- Climate and Radiation Branch
- Cryogenics Laboratory
- Data Assimilation Office
- Data Systems Technology Division
- Detector Development Laboratory
- Earth and Space Data Computing Division
- Electromechanical Systems
- Flight Data Systems
- Flight Mechanics Branch
- Geodynamics
- Global Change Data Analysis Center
- HPCC/Earth and Space Sciences (ESS) Project
- Hydrological Sciences Branch
- Interdisciplinary Research
- Laboratory for Astronomy and Solar Physics
- Laboratory for Atmospheres
- Laboratory for Extraterrestrial Physics
- Laboratory for High Energy Astrophysics
- Laboratory for Hydrospheric Process
- Laboratory for Terrestrial Physics
- Laser Instruments
- Launch Range
- Mechanical Engineering
- Mesocale Atmospheric Processes Branch
- Microwave Sensors Branch
- National Space Science Data Analysis Center
- Observational Science Branch
- Oceans and Ice Branch
- Optics Laboratory/Electro-Optics Laboratory
- Orbital Tracking
- Planetary Atmospheres
- Research Airport
- SeaWIFS Project
- Sounding Rocket Program
- Space Geodesy
- Terrestrial Information Systems
- Thermal Development Laboratory
- Tropical Rainfall Measuring Mission (TRMM) Office

Summary of Research Areas

Jet Propulsion Laboratory
- •Advanced Multi-Mode Avionic Design
- •Advanced Spacecraft Control Systems
- •Asteroid Dynamics
- •Astrophysics
- •Astrophysics
- •Atmospheric Remote Sensing
- •Autonomous Control Systems
- •Autonomous Mobile Vehicles
- •Concurrent Processing Devices and Neural Network Hardware
- •Control of Inflatable Antennas
- •Data Storage Technology
- •Earth Atmosphere
- •Earth Geosciences
- •Electric Power Research and Engineering
- •Electro-optical Tracking Systems
- •Flight Microelectronics System
- •Formation Flying of Multiple Spacecraft
- •Frequency Standards Research
- •Geodynamics
- •GPS Based Attitude Determination
- •HPCC/Earth and Space Sciences (ESS) Project
- •Imaging and Spectrometry Systems
- •Information Theory and Coding
- •Interferometer Technologies
- •Machine Vision Systems
- •Magnetic Device Technology
- •Microelectronic Radiation Hardness Assurance
- •Microwave Antenna Holography
- •Microwave, Lidar, and Interferomenter Technology
- •Mission Design
- •Mission Information Systems Engineering
- •Mission Profile and Sequencing
- •Multi-mission Spacecraft Avionics Core
- •Navigation Systems
- •Neural Network Algorithms
- •Oceanography
- •Optical Communication
- •Planetary Radar Astronomy
- •Planetary Atmospheres
- •Planetary Atmospheres and Interplanetary Media
- •Planetary Dynamics
- •Planetology
- •Precision Mechanisms and Motion Sensing
- •Project Test and Operations
- •Radar Remote Sensing of the Earth
- •Reliability Engineering
- •Robot Arm Control
- •Robotics Man-Machine Systems
- •Science Data Management and Archiving
- •Science Data Processing Systems
- •Software Product Assurance
- •Space Instruments Implementation
- •Space Physics
- •Spacecraft Autonomy
- •Spacecraft Systems Engineering
- •Systems Analysis
- •Systems Assurance
- •Technology and Applications Systems Engineering

Lyndon B. Johnson Space Center
- •Advanced Extravehicular (EVA) Systems
- •Advanced Life Support Systems
- •Artificial Intelligence
- •Biotechnology and Bioprocessing
- •Cardiovascular Research
- •Cell Science and Immunology
- •Computational Models for Human Factors
- •Computer Graphics Research
- •Earth Observations Database
- •Endocrine Biochemistry
- •Environmental Physiology/ Biophysics Research
- •Exercise Physiology
- •Flight Data Systems
- •Guidance, Navigation and Control
- •Human Factors/Research on Advanced Input Devices
- •Human Factors/Research on Human-Computer Interface
- •Immune Responses to Space Flight
- •Intelligent Robotics
- •Life Support Systems Analysis
- •Neuro-physiology
- •Orbital Debris
- •Pharmacokinetic Research
- •Planetary Materials Analysis
- •Propulsion and Power
- •Psychological Research
- •Risk Management
- •Robotic Applications
- •Robotic Simulation
- •Space Food Development
- •Space Radiation
- •Spacecraft Thermal Management
- •Systems Research
- •Tracking and Communications

John F. Kennedy Space Center
- •Advanced Systems and Analysis Division
- •Communications Division
- •Communications/Fiber Optics
- •Communications/Networks
- •Environmental/ Ecological Research
- •Flight Hardware Engineering
- •Industrial Engineering
- •KSC Safety and Shuttle Upgrades Modifications
- •Launch Processing System
- •Lightning Threat Detection
- •Plant Space Biology Research
- •Quality Engineering
- •Short-term Local Weather Prediction
- •Systems Safety

Langley Research Center
- •Advanced Computational Capability
- •Aerodynamics
- •Automated Information Security
- •Climate Research Program
- •Communication Technology
- •Design for Competitive Advantage

Summary of Research Areas

- Earth Radiation Budget Experiment (ERBE)
- Engineering
- Engineering Lab Team
- Facility Systems Engineering
- Flight Dynamics and Controls
- Fluid Mechanics and Acoustics
- Gas Dynamics
- Global Biogeochemical Cycling
- Halogen Occultation Experiment (HALOE)
- Hypersonic Vehicles Office
- Information and Electromagnetic Technology
- Management Information Systems Materials
- Materials Characterization Technology
- Mechanical Systems Engineering
- Spacecraft System Studies
- Stratospheric Aerosol and Gas Experiment (SAGE)
- Structures
- Technology Transfer/ Commercialization
- Transportation Systems
- Tropospheric Chemistry Research Program
- Upper Atmospheric Research

Lewis Research Center
- Advanced Composite Mechanics
- Airbreathing Propulsion Research and Technology for HypersonicVehicles
- Aircraft Icing
- Aircraft Power Transfer Technology
- Aircraft Propulsion Systems Analysis
- Antenna Technology
- Ceramic-Matrix Composite
- Computational Fluid Mechanics
- Computational Structures Technology
- Computational Technology
- Concurrent Engineering Simulation Controls and Dynamics
- Deformation and Damage Mechanics
- Digital System Technology
- Electrochemical Space and Storage
- Emissions Technology
- Environmental Durability of Advanced Materials
- Experimental Fluid Mechanics
- Fan/Propeller Aerodynamics and Acoustics
- Fatigue Life Protection
- High Performance Computing and Communications/Numerical Propulsion System Simulator
- High Temperature Electronics Technology
- In-Space Technology Experiments
- Instrumentation and Controls Technology
- Low Noise Nozzle Technology
- Microgravity Materials Science
- Microgravity Science and Applications
- On-Board Propulsion
- Optical Measurement Systems
- Photovoltaic Space Systems
- Polymers and Polymer Matrix Composites
- Power Materials Technology
- Power Systems Technology
- Probabilistic Structural Mechanics
- Propulsion System Health Management
- Satellite Networks and Architectures
- Selected Liquid Rocket Propulsion Technologies
- Sensors
- Solar Array Power
- Solar Dynamic Power Systems
- Solid State Technology
- Space Environmental Interactions
- Space Power Management and Distribution Technology
- Stirling Dynamic Power and Refrigeration Systems
- Structural Dynamics
- Structural Integrity
- Thermal Management Technologies
- Tribology & Surface Science
- Turbomachinery Technology
- Vacuum Electronics

George C. Marshall Space Flight Center
- Aerosol Backscatter and Lidar Studies
- Atmospheric Chemistry
- Atmospheric Electricity Studies
- Audio Systems
- Battery Cell Analysis
- Biophysics
- Climate Diagnostics and the Global Hydrologic Cycle
- Combustion Devices and Turbomachinery
- Communications Systems
- Component Development Division
- Computational Fluid Dynamics
- Control of Space Vehicles and Robotic Manipulators
- Cosmic Ray Research
- Crystals Growth in Fluid Field and Particle Dynamic Evaluation
- Electrical Systems
- Electronics and Sensors
- Expert Systems
- Flight Operations
- Gamma Ray Astronomy
- Global Passive Microwave Studies
- Ground Support Systems
- Human Factors
- Hydrometeorology/Land Surface Interface
- Hypervelocity Impact Design and Analysis
- Infrared Water Vapor Measurements
- Liquid Propulsion Dynamic Analysis
- Metallic Materials
- Microgravity Solidification
- Microwave Measurements
- Nonmetallic Materials Research

Summary of Research Areas

- •Optical Systems
- •Pointing Control Systems
- •Propulsion and Motor Systems Division
- •Quality Assurance Office
- •Reliability Engineering
- •Software Systems
- •Solar Physics
- •Space Environmental Effects on Materials
- •Space Plasma and Upper Atmospheric Physics
- •Structural Assessments Structural Analysis
- •Structural Design Optimization/ Synthesis
- •Structural Dynamics
- •Systems and Components Test and Simulation
- •Systems Division
- •Systems Safety Engineering
- •Test Division
- •Thermal Analysis: Liquid Propulsion Systems
- •Thermal Analysis: Solid Rocket Motor
- •Thermal/Environmental Computational Analysis
- •Training/Training Systems
- •Vibroacoustics
- •X-Ray Astronomy

John C. Stennis Space Center

- •Active and Passive Non-intrusive Remote Sensing of Propulsion Test Parameters
- •Advanced Propulsion Systems Testing
- •Archeological/Anthropological Predictive Modeling
- •Coastal Processes
- •Commercial Remote Sensing
- •Cryogenic Instrumentation and Cryogenic, High Pressure, and Ultrahigh Pressure Fluid Systems
- •Ground Test Facilities Technology
- •Image Compression
- •Leak Detection, Sensors, Quantification, and Visualization
- •LOX/GOX Compatible Materials
- •Materials and Fluid Science
- •Paleoecological Research/Human Adaptations
- •Physiological Ecology
- •Propellant and Pressurants Conservation, Recycling, and Energy Conservation
- •Propulsion System Testing Techniques, Simulation, Modeling, and Methodologies
- •Remote Sensing and Plant
- •Research Software
- •Spectroscopy Technology for Propulsion System Testing
- •Thermal Protection and Insulation Systems
- •Use of Visualization Technologies of SSC Data Analysis
- •Vehicle Health Management/ Rocket Exhaust Plume Diagnostics

Office of Space Science

NASA Headquarters

The NASA Headquarters Office of Space Science (OSS) supports basic and applied research in space science. The OSS research program includes the development of major space flight missions such as the Advanced X-Ray Astronomical Facility and the Cassini Mission to Saturn, complementary laboratory research and analysis of data from prior missions, and theoretical studies.

Program Administrator:
Ms. Dolores Holland
Office of Space Science
Code S
National Aeronautics and Space Administration
Washington, DC 20546-0001
(202) 358-0734

Mail Office of Space Science proposals to:
Graduate Student Researchers Program
Code SPM-20
NASA Headquarters
Washington, DC 20546-0001

Proposals sent by express mail, commercial delivery or courier to:
Graduate Student Researchers Program
Code SPM-20
Attn: Receiving and Inspections
NASA Headquarters
300 E Street, SW
Washington, DC 20024-3210

Within the Office of Space Science, activities are organized into four major theme areas. A brief description of these themes follows:

Structure and Evolution of the Universe — *addresses cosmology, large scale structure of the universe, evolution of stars and galaxies, including the Milky Way and objects with extreme physical conditions. Questions of interest are: What is the universe? How did it come into being? How does it work? What is its ultimate fate?*

This theme encompasses research in the areas of cosmology, the evolution of stars and galaxies, large-scale structure of the universe, the end products of stellar evolution such as supernovae and their remnants, neutron stars and black holes, the unsolved mysteries of dark matter and gamma-ray bursts, and the physical laws governing the universe. It includes high energy astrophysics (x-ray and gamma ray astronomy), galactic cosmic rays (also referred to as particle astrophysics), extreme ultraviolet astronomy, submillimeter and radio astronomy from space, and gravitation and relativity studies in space. It covers space observations in the electromagnetic spectrum roughly shortward of 912 angstroms and longward of 100 microns. Emphasis is placed on the development and implementation of a multiwavelength program of space-based and suborbital missions (airborne, sounding rockets, balloons). Investigations that support instrumentation development relevant to future missions in the above areas, the analysis of data from ongoing and past missions, and laboratory and theoretical investigations that support the interpretation of relevant space-based observations are invited.

Astronomical Search for Origins and Planetary Systems — *addresses the origins of galaxies, stars, protoplanatary disks, extrasolar planetary systems, Earth-like planets, and the origin of life. Questions of interest are: How were galaxies born? How do stars and solar systems form? Are there other Earth-like planets?*

Research in Origins is directed toward obtaining a greater understanding of the origin of galaxies, stars, solar systems, and perhaps, life itself. Emphasis is placed on the development and implementation of a multiwavelength program of space-based and suborbital missions (airborne, sounding rockets, balloons). Programs that support instrumentation development relevant to future missions, the analysis of data from ongoing and past missions, and on laboratory and theoretical investigations that aid in the interpretation of space-based observations are encouraged.

Solar System Exploration — *addresses scientific activities that pertain to the solar system, including comets, and major and minor planets. Questions of interest are: What is the origin of the Sun, the Earth, and the planets, and how did they evolve? Are there worlds around other stars? What are the ultimate fates of planetary systems? What threat is posed by the potential for collisions with Earth-approaching objects?*

Office of Space Science

Solar system research focuses on the origin, evolution, and current state of the various bodies in the solar system, including their interiors, surfaces, and atmospheres and the origin, evolution, and distribution of life beyond the Earth in the solar system. Research exploits analysis of data collected by ground-based and satellite borne instruments, laboratory experiments, and theoretical modeling. Relevant research topics include studies of the planets, rings, moons, asteroids, and comets; analysis of lunar, meteorite, cosmic dust samples; and analysis of data returned from spacecraft. Areas of research interest include planetary geology and geophysics, materials and geochemistry, exobiology, planetary atmospheres, planetary astronomy, and planetary system science.

The Sun-Earth Connection — *addresses the sphere of influence of the Sun on the Earth environment. Questions of interest are: What causes solar variability? How does the sun and its variability affect the Earth and other planets?*

Research in the Sun-Earth Connections theme focuses on investigations of the Sun, both as a nearby star and as a source of variable outputs of solar wind, energetic particles, and electromagnetic radiations with influence on the Earth and its space environment, on planetary and cometary magnetospheres, and on the heliosphere. The program involves investigations of the origin, evolution, and physics of plasmas, electromagnetic fields, and energetic particles in space. Studies of the terrestrial space environment include investigations of the coupling between the variable Sun and the Earth's magnetosphere, ionosphere, thermosphere, and mesophere. Measurements are made from balloons, rockets, satellites, and deep space probes. Theory and computer simulations are also supported.

Office of Space Science opportunities offered in Information Systems, are as follows:

INFORMATION SYSTEMS

Information Systems research focuses on providing new capabilities for data archives and directories, computer networking, and high-performance computing in support of space science. The program includes development of generic tools and capabilities, testbed efforts to demonstrate and evaluate advanced technologies for NASA, technology demonstrations, and research efforts in areas such as graphics and visualization, algorithms, data storage technologies, and access methods applicable to the space science disciplines and research themes.

Office of Life and Microgravity Sciences and Applications

NASA Heaquarters

The Office of Life and Microgravity Sciences and Applications (OLMSA) leads the nation's efforts in life and microgravity sciences, related technology development and applications using the attributes of the space environment to advance knowledge, to improve the quality of life on Earth, and to strengthen the foundations for continuing the exploration and utilization of space.

OLMSA is within the Human Exploration and Development of Space (HEDS) Enterprise and shares the mission to open the Space frontier by exploring, using and enabling the development of Space and to expand the human experience into the far reaches of Space. The four OLMSA divisions are: Flight Systems; Aerospace Medicine and Occupational Health; Life Sciences; and Microgravity Science and Applications.

Program Administrator:
Ms. Georgia A. LeSane
Office of Life and
Microgravity Sciences
and Applications
Code UP
NASA Headquarters
Washington, DC 20546-0001
(202) 358-0123

Mail OLMSA proposals to:
Graduate Student
Researchers Program
Attn: Ms. Kathleen Wilson
Information Dynamics, Inc.
300 D Street, SW
Suite 801
Washington, DC 20024

Proposals sent by express mail, commercial delivery, or courier to:
Graduate Student
Researchers Program
Code UP
ATTN: Receiving and
Inspection
NASA Headquarters
300 E Street, SW
Washington, DC 20024-3210

MICROGRAVITY SCIENCE AND APPLICATIONS

The Microgravity Science and Applications Division (MSAD) conducts a program of physical sciences and process research within the Human Exploration and Development of Space strategic enterprise of NASA. This research is managed within four disciplines: Biotechnology, Combustion Science, Fluid Physics, and Materials Science, and one topical area of emerging definition, Fundamental Physics. Research sponsored by MSAD uses the unique attributes of the space environment to advance scientific knowledge and technology, and uses advances in scientific knowledge to better understand the performance of technologies in the unique environment of space. The program includes ground-based research, predominantly conducted within colleges and universities, advanced technology development activities, and flight investigations conducted aboard the Space Shuttle, the Mir space station, and, beginning in 1999, aboard the International Space Station.

LIFE SCIENCES

The Life Sciences Division involves multidisciplinary research areas in the biomedical and biological sciences. Research focuses on: space biology, space physiology, and countermeasures; radiation health; human factors; and advanced life support systems. The program includes ground-based research and technology development and the flight of equipment and instruments for human, animal, plant, and cellular experiments on board the Space Shuttle, in the Spacelab laboratory module, and on other Earth-orbiting spacecraft.

Mission to Planet Earth

NASA Headquarters

The NASA Headquarters Office of Mission to Planet Earth (MTPE) supports basic and applied research in Earth system science. The NASA Earth System Science Graduate Student fellowships targets students pursuing advanced degrees in fields supporting the study of Earth as a system.

Program Administrator:
Dr. Ghassem Assar
Office of Mission to Planet Earth
Code Y
National Aeronautics and Space Administration
Washington, DC 20546-0001
(202) 358-0273

Mail proposals to:
Earth System Science Fellowship Program
Code Y
400 Virginia Ave., SW
Suite 700
Washington, DC 20024

The near-term (1996-2000) scientific priorities of NASA's Mission to Plant Earth include:

- Seasonal-to-lnterannual Climate Prediction: providing global observations and scientific understanding to improve forecasts of the timing and regional extent of transient climate anomalies.
- Long-term Climate Variability: provide global observations and scientific understanding of the mechanisms and factors which determine long-term climate variations and trends.
- Land Cover Change and Global Productivity: document and understand the trends and pattern of changes in land-cover, biodiversity, and global primary production by both oceanic and terrestrial ecosystems.
- Atmospheric Ozone: detecting causes and consequences of changes in atmospheric ozone.
- Natural Hazards: apply unique Mission to Planet Earth remote sensing science and technologies to disaster characterization and risk reduction from earthquakes, fires, floods, droughts and other natural disasters.

Applications will be considered for research on climate and hydrologic systems, ecological systems and dynamics, biogeochemical dynamics, solid Earth processes, human interactions, solar influences, and data and information systems. Atmospheric chemistry and physics, ocean biology and physics, ecosystem dynamics, hydrology, cryospheric processes, geology, and geophysics are all acceptable areas of research, provided that the specific research topic is relevant to NASA's Earth remote sensing efforts in support of the U.S. Global Change Research Program (USGCRP). NASA discourages submission of paleo-climate related applications to this program.

Stipends are identical and most administrative procedures are similar to the GSRP. Approximately forty new fellowships will be awarded in the 1997 academic year. More detailed information on the Earth System Science Fellowship Program will be available on the Internet *http://www.hq.nasa.gov/office/mtpe* (under "Publications and Education Programs"). Printed copies can be requested by calling (202) 358-3552 and leaving a voice mail message, or by writing:

Earth System Science Fellowships
Office of Mission to Planet Earth
Mail Code YSP-44
NASA Headquarters
300 E Street, SW
Washington, DC 20546

Ames Research Center

Moffett Field, CA

The Ames Research Center conducts research activities, technology programs, and flight projects that advance the nation's capabilities in civilian military aeronautics, space sciences, and space applications. This diverse program at Ames is organized into aeronautics, information systems, and space.

In preparing a proposal for a fellowship at Ames Research Center, prior collaboration with an Ames researcher is mandatory. A suggested point of contact is listed with each research topic for which a student may apply.

Program Administrator:

Ms. Meredith Moore
Mail Stop 241-3
NASA Ames Research Center
Moffett Field, CA 94035
(415) 604-5624
email address:
mmoore@mail.arc.nasa.gov

AERONAUTICS

In aeronautics, Ames concentrates on rotorcraft and powered lift aircraft technology, fluid mechanics, experimental aerodynamics, flight simulation, flight systems research, advanced air traffic management system, and human factors.

George Kidwell
(415) 604-1847

Experimental Aerodynamics — Low-speed testing in the 12x24–, 24x37-, and 2x3-meter wind tunnels. Development of computational/empirical prediction methods for powered lift and conventional lift configurations. Prediction and analysis of acoustic characteristics of aircraft configurations and wind tunnel facilities. Development and application of nonintrusive measurement techniques.

Larry Olson
(415) 604-6681

Air Traffic Management — Conflict detection and resolution, air traffic control automation, air traffic information management and display.

Heinz Erzberger
(415) 604-5425

High Performance Computing and Communications (HPCC)/ Computational Aerosciences Project — Current advances in high performance computing are coming from novel computer architectures such as parallel processors, vector processors, and heterogeneous networks of computers. The suitability of these architectures to solving problems of interest to NASA and the development of new architectures that efficiently solve these problems is the objective of this research. Of particular interest is the investigation of architectures to solve problems arising in computational fluid dynamics as governed by the Navier-Stokes equations. These investigations could include software issues as well as hardware issues because the ultimate goal is to provide the researcher at Ames with improved computational resources. Current computational resources include CRAY C90's and IBM SP2, as well as a network with powerful workstations and superminis.

Kenneth Stevens, Jr.
(415) 604-5649

Scientific Visualization and Interactive Computer Graphics
This research is aimed at the creation of a highly interactive and visual environment for scientists who are developing computer simulations of physics or who are required to analyze large 3-D data–sets. Current research is being done using Silicon Graphics Workstations connected to supercomputers.

Tom Lasinski
(415) 604-4405

Computational Fluid Dynamics
Theoretical research in fluid dynamics using the Euler and the Navier-Stokes equations, both compressible and incompressible. Includes research on basis equation formulations, algorithm development, and code efficiency, as well as the physics of laminar and turbulent flow fields.

Thomas H. Pulliam
(415) 604-6417

Ames Research Center

Turbulence Physics — Study of the fundamental physics of turbulent and transitional flows through numerical simulations and experiments. Studies include developing numerical algorithms suitable for direct and large-eddy simulations of turbulent flows, developing tools for analyzing computer-generated, databases, developing turbulence models for engineering applications, and performing experiments to understand flow physics and support turbulence model validation.

Nagi Mansour
(415) 604-6420

Aeronautical Fluid Mechanics — Research areas under investigation include dynamic stall control, drag reduction of airfoils and wings, and the control of supersonic transition. Experimental, computational, and theoretical tools are developed and used in both basic and applied studies.

Sanford Davis
(415) 604-4197

Aircraft Conceptual Design — Development of aircraft design synthesis techniques that incorporate optimization routines, expert system concepts, and graphical user interfaces on a system of networked computer workstations. Studies are broad in nature, encompassing the subsonic to hypersonic speed ranges, and including such concepts as rotorcraft, fixed-wing, and transatmospheric vehicles. Analyses include a total transportation systems approach and consider market requirements and economics.

Thomas L. Galloway
(415) 604-6181

Rotorcraft Aeromechanics — Experimental and theoretical research programs to improve performance, vibration, and noise of advanced rotorcraft. Studies include basic investigations of the aerodynamics, dynamics, and acoustics of rotor systems for helicopters, tilt rotors, and other advanced configurations. Experiments are performed in the Ames 7 x 10-foot wind tunnel and in the National Full-Scale Aerodynamics Complex, including the 40 x 80-foot wind tunnel.

William Warmbrodt
(415) 604-5642

Computer Vision — Computer vision and image understanding techniques are being applied to the navigation of rotorcraft and aircraft during low-altitude flight, landing and taxing. The techniques are quite general and can be used in the autonomous guidance of other types of vehicles.

Banavar Sridhar
(415) 604-5450

Flight Research — Simulation investigations, guidance and navigation, aircraft automation, flight dynamics, advanced control theory (helicopter V/STOL applications).

William Hindson
(415) 604-1106

Human Factors — Crew performance, aviation safety, aircraft operating systems advanced spatial displays and instruments, virtual environments, high-fidelity simulation-based human performance assessment, operator interfaces to intelligent systems and advanced automation.

Mike Shafto
(415) 604-6170

INFORMATION SYSTEMS

As the Center of Excellence for Information Technology (COE-IT), Ames' primary mission will be to provide strategic research focus and Agency-level coordination of NASA's investment in advanced information technology. Ames' role is to pioneer and lead the research, development, and implementation of information technologies to support NASA's Aeronautics and Space Enterprises and missions. In support of the four NASA Strategic Enterprises - Aeronautics, Space Science, Human Exploration and Development of Space, and Mission to Planet Earth - five information technology focus areas have been identified: Integrated Design Systems; Large-Scale Information Management and Simulation; Aviation Operations; Space Systems Operations; and Autonomous Systems for Space Flight.

Applied Information Technology
As an expert center for computer security and workgroup/workflow, Ames will play a considerable role in developing and integrating the "Office of the Future" into the NASA environment. Taking advanced technologies from Ames' Information Technology Center of Excellence and from industry, engineers and computer scientists will adapt these concepts to desktops throughout the Agency.

Scott Santiago
(415) 604-5015

Ames Research Center

Artificial Intelligence — Basic and applied research is conducted in the framework of aerospace domains including space transportation, space science, and aeronautics. Three research areas are emphasized: Planning (including both goal - and resource-driven approaches); machine learning (entire spectrum from empirical to knowledge-intensive); and the design of and reasoning about large-scale physical systems (including work in knowledge acquisition, knowledge base maintenance, and all applications to the design process).

Silvano Colombano
(415) 604-4380

Neuroengineering — Basic and applied research is conducted in intelligent computational systems technology for Aeronautics and Space Missions. Activities address soft computing technologies for real time performance and adaptability in dynamically changing environments. Current research programs include real time reconfiguration control for damaged air and spacecraft, early design augmentation and performance estimation using neural, fuzzy, and genetic algorithms, virtual reality simulation of early design prototypes, real-time signal and pattern recognition for fault diagnosis, and evaluation of neural and fuzzy set processing architectures. Emphasis is placed on new methods for rapid gradient search and system identification, integration of soft computing technology with graphic simulation, and new analysis tools to verify adaptive algorithm performance, robustness, convergence, and certification.

Chuck Jorgensen
(415) 604-6725

SPACE

The Space Directorate at Ames manages activities in research and technology development in support of NASA's space programs. Work is done in Space Sciences, Life Sciences and Earth Sciences; in addition, programs are conducted in Space Technology and in Space Flight Projects.

Space Technology — The work of Space Technology includes both research and development of devices and systems that will be needed on future space missions. Research areas range from the application of computer capabilities simulating the physical and chemical environment, to the direct collection of physical and chemical data. Areas of technology development range from thermal protection during atmosphere entry to methods of rapid and complete organic waste oxidation.

Aerothermodynamics — Provides aerothermodynamic flow-field computational capability to analyze and design advanced space transportation concepts. Also provides the analytical and turbulence chemistry models required to compute the viscous/finite-rate flow field and to predict radiation heating to conceptual aero-assisted orbital vehicles.

Thomas A. Edwards
(415) 604-4465

Aerothermal Materials and Structures — Develops lightweight reusable ceramics and carbon-carbon Thermal Protection Systems (TPS) for transient, high-velocity atmospheric penetration and develops expendable TPS for planetary probes.

Daniel Rasky
(415) 604-1098

Computational Chemistry — Application of molecular structure, molecular dynamics and molecular modeling techniques to a wide range of problems of NASA interest. Current research activities are focused on nanotechnology, device modeling high-energy density materials, combustion research, polymers, astrophysics, aerothermodynamics, and atmospheric chemistry. Specifically, we are interested in computing accurate thermodynamic properties, vibrational frequencies and intensities, molecular line strengths, reaction rates, electron-molecule cross sections, transport properties and spectroscopic constants. We are also interested in porting and extending code for current and next generation parallel architectures.

Stephen R. Langhoff
(415) 604-6213

Applied Computational Fluid Dynamics — This area deals with the development of new computational methodology involving aerodynamic and/or fluid dynamic application associated with incompressible, subsonic, transonic, speeds. Computer codes are constructed and evaluated for applications associated with aircraft or aircraft component aerodynamics, rotorcraft aerodynamics, high-angle-of-attack flows, unsteady flows, and flows with aeroelastic effects.

William R. Van Dalsem
(415) 604-4469

Hypersonics — This area deals with the development of new computational methodology involving aerodynamic and/or fluid dynamic applications associated with hypersonic flight speeds. The physical aspects of this flight regime require emphasis on algorithms/codes with accurate heat transfer prediction capabilities, strong shock capturing abilities and chemical equilibrium and nonequilibrium models for air and other planetary atmospheres.

John A. Cavolowsky
(415) 604-4434

Life Support — Research is conducted in the broad area of regenerative life support for space: the conservation and re-use of materials consumed by space crews. Issues of interest include the use of physical and chemical devices for air regeneration, water purification, waste management and oxidation and atmosphere contaminant control. Also of interest are systems control, systems modeling and simulation and the potential role of biological systems in life support supplementation. Mechanical systems of interest include some aspects of space suit design.

Mark Kliss
(415) 604-3203

SPACE SCIENCES

In space science, Ames concentrates on research directed at enhancing understanding of the origins, evolution, current state of the universe, the solar system, the Earth, and life. Principal efforts focus on a multidisciplinary approach to research activities in space science and life science. Particular emphasis in space science is placed on infrared science and climatology, Earth airborne sciences, and the development and application of selected flight projects and areas of space technology relevant to those research needs.

Infrared Astronomy Projects and Technology Development — Current research is focused on the integration of the design tools to allow full system simulation prior to SOFIA operation. The technology tasks include IR detectors and cryogenics. Multi-element IR detector arrays are developed and characterized for space astronomy. Advanced efficiency cooling techniques are developed for space.

Chris Wiltsee
(415) 604-5917

Theoretical Astrophysics — Research is being conducted on star formation, circumstellar disks, the physics and chemistry of the interstellar medium, and the formation and dynamical evolution of galaxies. Theoretical models involve the application of computational techniques to problems in astrophysical gasdynamics, radiative transfer, and many-body systems.

Pat Cassen
(415) 604-5597

David Hollenbach
(415) 604-4164

Planetary Science — Research in this area includes atmospheric, chemical, radiative, and dynamic models, remote sensing of planetary ring dynamics.

Pat Cassen
(415) 604-5597

Jeff Cuzzi
(415) 604-6343

Solar System Exploration — Solar system exploration research defines flight experiments and related data bases and develops analytical concepts and prototype flight instrumentation for the extraterrestrial study of exobiology (history of the biogenic elements, chemical evolution, and origin and early evolution of life). Particular emphasis is placed on the biogenic elements (C, H, N, O, P, S) and their compounds as they relate to the composition and physical characteristics of the various bodies and materials of the solar system, such as cometary nuclei and comae and planetary atmospheres and surfaces. Experiment and instrument definition studies for Mars, interplanetary dust particles, and comet sample return are currently being conducted.

Glenn Carle
(415) 604-5765

Exobiology — Interdisciplinary research in planetary biology is aimed at understanding the factors in cosmic, solar system, and planetary development that have influenced the origin, distribution, and evolution of life in the universe and the course of interaction between biota and earth's surface environments.

Sherwood Chang
(415) 604-5733

LIFE SCIENCES

In life sciences, Ames concentrates on biomedicine (the effects of the space environment on man and other organisms); extraterrestrial research; and biosystems (the ability to support man in the space environment).

Space Biology — Space biology research uses the space environment, particularly weightlessness, and ground-based space flight simulations to investigate basic scientific questions about the role of gravity in present-day terrestrial biology and the role it has played during the evolution of living systems. The research is divided into the disciplinary areas of biological adaptation, gravity sensing, and developmental biology. Experiments are carried out at the subcellular, cellular, tissue, organ, and system levels in differing organisms of the five kingdoms of life.

Emily Holton
(415) 604-5471

Neurosciences — Research in neuro-sciences examines how the nervous system adapts to environmental conditions encountered in space, how adaptive processes can be facilitated, and how human productivity and reliability can be enhanced. To elucidate mechanisms underlying adaptation, neurosciences research includes neurochemistry, neuroanatomy, neurophysiology, vestibular physiology, psychophysiology, and experimental and physiological psychology. State-of-the-art facilities include: human and animal centrifuges, linear motion devices, an animal care facility, a human bed-rest facility, and NASA's Vestibular Research Facility.

Mal Cohen
(415) 604-6441

Space Physiology — Multidisciplinary research in space physiology emphasizes the effects of hypergravity, gravity and microgravity on cardiovascular, musculoskeletal, and regulatory systems of humans and animals. Actual microgravity and ground-based models of simulated microgravity are used to investigate basic mechanisms of adaptation to space and readaptation to Earth. Physiological, biomechanical, cellular, and biochemical factors are also studied to develop appropriate countermeasures for maintaining health, well-being, and performance of humans in space.

Alan Hargens
(415) 604-5746

EARTH SYSTEM SCIENCE

In Earth System Science, the focus at Ames is to perform and lead research within the disciplines of atmospheric and ecosystem science, with particular emphasis on how the biosphere and atmosphere interact to influence the evolution of the global system on all time scales.

Ecosystem Science and Technology — Interdisciplinary research in ecosystem science and technology looks at the role of life in modulating the complex cycling of materials and energy throughout the biosphere. Intact ecosystems, with particular emphasis on temperate and tropical forests, are examined by remote sensing from aircraft and spacecraft and by field site visits, with subsequent laboratory and computer analysis of the data gathered.

Estelle Condon
(415) 604-6071

Earth Atmospheric Chemistry and Dynamics — Research in this area includes the development of models and the use of airborne platforms and spacecraft to study chemical and transport processes that determine atmospheric composition, dynamics, and climate. These processes include the effects of natural and man-made perturbations.

Phil Russell
(415) 604-5404

Ecosystem Science — Research in this area is directed to advanced understanding of the physical and chemical processes of biogeochemical cycling and ecosystem dynamics of terrestrial and aquatic ecosystems through the utilization of aerospace technology.

David Peterson
(415) 604-5899

Hugh L. Dryden Flight Research Center

Edwards, CA

The Dryden Flight Research Center program includes most engineering disciplines in aeronautics with emphasis on flight systems integration and flight dynamics. The following descriptions identify the current activities relevant to the Dryden program for which qualified students may apply.

Program Administrator:

Dr. Kajal K. Gupta
Dryden Flight Research Center
P.O. Box 273
Edwards, CA 93523
Phone (805) 258-3710

Advanced Digital Flight Control
Modeling, simulation, and flight test of distributed control systems. Design criteria and methods for unconventional vehicles, including decoupling of asymmetrical airplanes and stabilization of highly unstable airframes.

Robert Clarke
(805) 258-3799

Flight Systems — Engineering aspects of the formulation, design, development, fabrication, evaluation, and calibration of flight control, avionic, and instrumentation systems used onboard complex, highly integrated flight research vehicles. Work with fault tolerant redundant microprocessor-based control systems, microprocessor-based measurement systems, transducers, actuators, techniques for system safety, and hazard analysis.

Vince Chacon
(805) 258-3791

Flight Dynamics — Pilot/aircraft interaction with advanced control systems and displays, assessing and predicting aircraft controllability, developing flying qualities criteria, parameter estimation, and mathematical model structure determination.

Robert Clarke
(805) 258-3799

Flight Test Measurement and Instrumentation — Flow measurement, skin friction drag, fuel flow, integrated vehicle motion measurements, space positioning, airframe deflection, sensor and transducer miniaturization, and digital data processing.

Rodney Bogue
(805) 258-3193

Fluid Mechanics and Physics — Laminar and turbulent drag reduction configuration aerodynamics, experimental methods, wing/body aerodynamics, full-scale Reynolds number test technology, high angle of attack aerodynamics, applied mathematics, and atmospheric processes.

Robert Meyers
(805) 258-3707

Propulsion/Performance — Propulsion controls, integrated propulsion/airframe systems, and vehicle performance measurement.

Larry Myers
(805) 258-3698

Structural Dynamics — Aerostructural modeling, vibration and flutter analyses/predictions, aircraft flutter, flight envelope expansion, ground vibration and inertia testing, aeroservo/elasticity, active control of structural resonances, and advanced flight test technique development.

Mike Kehoe
(805) 258-3708

Aircraft Automation — Knowledge-based systems development, verification and validation of knowledge-based systems, neural networks, heuristic controllers, knowledge-based acquisition/implementation, maneuver controllers, performance optimization, guidance, pilot-vehicle interface, and robotic aircraft.

Lee Duke
(805) 258-3802

Integrated Test Systems and Aircraft Simulation — Development of Integrated System Test equipment, including aircraft/ simulation interface equipment, automated test equipment, and applied artificial intelligence techniques for diagnosis and control. Flight simulation development for advanced aircraft systems in aerodynamic, propulsion, and flight control modeling.

Dale Mackall
(805) 258-3408

Goddard Space Flight Center

Greenbelt, MD

The mission of Goddard Space Flight Center is to expand knowledge of the Earth and its environment, the solar system, and the universe through observations from space. To assure that our nation maintains leadership in this endeavor, we are committed to excellence in scientific investigation, in the development and operation of space systems, and in the advancement of essential technologies.

Graduate Student Researchers Program opportunities are available in the Space Sciences Directorate, the Earth Sciences Directorate, the Engineering Directorate, and the Mission Operations and Data Systems Directorate. Research opportunities at Goddard's two remote facilities—the Goddard Institute for Space Studies in New York City and the Wallops Flight Facility on Wallops Island, VA—are included in these listings. Qualified applicants are strongly encouraged to explore areas of interests with the contacts listed prior to submitting a proposal. All proposals should come to the program office in Greenbelt, MD.

Program Administrator

Dr. Gerald Soffen
Director of University Programs
NASA
Goddard Space Flight Center
Code 160
Greenbelt, MD 20771
(301) 286-9690
Internet address: http://university.gsfc.nasa.gov/GSRP/GSRP.html

SPACE SCIENCES DIRECTORATE

The Space Sciences Directorate plays a leading role in conceiving and developing instruments and missions for the scientific exploration of space.

The Orbiting Satellites project in the Directorate manages operating scientific spacecraft which were developed by Goddard. The Directorate's Space Science Data Operations Office designs, develops, and operates data management and archiving systems and provides public access to archived space science data.

Laboratory for High Energy Astrophysics — High Energy Astrophysics is the study, by way of X-rays, gamma rays, and energetic particles, of cosmic systems and sites and the physical processes operating therein. Studies of the mechanisms that release energy and accelerate particles, and of the thermal and non-thermal mechanisms that convert the kinetic energy of these particles into observable radiation, are the essential ingredients of high energy astrophysics. High energy observations and theory address some of the most fundamental problems in astrophysics: the accretion disks around, and magnetospheres of, massive compact objects such as neutron stars and black holes; abundance distributions of hot astrophysical plasmas such as stellar atmospheres, supernova remnants, galactic cosmic rays and intercluster gas; the origin of gamma-ray bursts; the natural acceleration of particles in space; the central engines of Active Galactic Nuclei; and the character and location of "dark matter" and the nature of large scale extragalactic structures. A broad program of experimental and theoretical research is conducted in all phases of astrophysics associated with high energy particles and the quanta produced in the interactions with their environments. The observables are features such as compositions, time variability, spatial structures, and spectral features of the X-ray and gamma-ray emissions and particle populations. Experiments are designed, built, tested, and flown on balloons, rockets, Earth satellites and deep space probes. The resulting data are analyzed and interpreted by Laboratory scientists and their associates in the larger high energy astrophysics community. These studies of the physics of solar, stellar, galactic, and metagalactic high-energy processes lead to development of theoretical models of the origins and histories of these particles and quanta, and provide understanding of the objects and environments in which they arise.

N. White
(301) 286-8443
Archival X-ray and gamma ray data analysis

E.A. Boldt
(301) 286-5853
Cosmological X-ray studies

J. Swank
(301) 286-9167
Stellar X-ray sources

R. Mushotzky
(301) 286-7579
Extragalactic X-ray sources

Goddard Space Flight Center

C.E. Fichtel
(301) 286-6281
High Energy (>20MeV)
gamma rays

T.L. Cline
(301) 286-8375
Low energy (0.02 - 20 MeV)
gamma rays

J.F. Ormes
(301) 286-8801
Cosmic Rays

R. Ramaty
(301) 286-8715
Theoretical studies

Laboratory for Astronomy and Solar Physics — The Laboratory for Astronomy and Solar Physics conducts a broad program of research in both observational and theoretical astronomy and solar physics. Observational programs, including technology and instrumentation development, span the spectral range from X-ray to radio wavelengths. Astrophysical phenomena of the Sun and stars are studied with emphasis on their structure, origin, and evolution. Investigations of the gross dynamics and transient properties of the atmospheres of the Sun and other stars are carried out, emphasizing phenomena revealed by spectroscopic observations made above the Earth's atmosphere and correlated with ground-based observations.

Data of interest to laboratory scientists are currently being obtained from the Solar and Heliospheric Observatory (SOHO), providing new opportunities for study of the solar corona, and the Goddard High Resolution Spectrograph (GHRS) on the Hubble Space Telescope. Lab personnel are performing analysis on archival data from these missions, as well as from the International Ultraviolet Explorer (IUE), the Cosmic Background Explorer (COBE), the Solar Maximum Mission (SMM), the Infrared Astronomical Satellite (IRAS) and the Ultraviolet Imaging Telescope (UIT) on the Astro Mission. Soon the Space Telescope Imaging Spectrograph (STIS) should produce diffraction-limited spectral imagery when installed in the Hubble Space Telescope.

Laboratory staff are participating in the development of the Far Ultraviolet Spectroscopic Explorer (FUSE), and are preparing proposals for the High Energy Solar Imager (HESI) and Microwave Anisotropy Probe (MAP) Explorer missions. Conceptual and technology studies for infrared array cameras on various platforms including the Space Infrared Telescope Facility (SIRTF) are also in progress. Active suborbital observing programs are carried out from groundbased, airborne, balloon-borne, and rocket-borne instruments.

Charles Bennett
(301) 286-3902
Infrared Astronomy

Susan Neff
(301) 286-5137
UV-Optical Astronomy

Richard Fisher
(301) 286-5682
Solar Physics

Andrew Michalitsianos
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Laboratory Chief

Laboratory for Extraterrestrial Physics — The Laboratory for Extraterrestrial Physics (LEP) performs experimental and theoretical research on the physical properties of and dynamical processes occurring in the interplanetary and interstellar media, magnetospheres and upper atmospheres of the planets, including Earth.

A major effort in the LEP is the analysis of data from spacecraft experiments flown on Voyagers 1 and 2, ULYSSES, IMP-8, GEOTAIL, WIND, POLAR, and suborbital rocket payloads. The research focuses on plasmas, magnetic fields, electric fields, and radio waves located in planetary magnetospheres and the interplanetary medium. A program in infrared astronomy includes the study of spectra of the outer planets to deduce atmospheric properties, as well as an incipient program for the detection and spectroscopy of extra-solar planets. Studies of planetary atmospheres and the solar spectrum in the infrared are also conducted.

An extensive program of research, including spectroscopy and physical chemistry related to astronomical objects, studies of molecules and chemical reactions of astrophysical and aeronomic importance are also conducted in special laboratory facilities. Research related to the chemistry and physics of planetary stratospheres and tropospheres, and solar system matter including meteorites, asteroids, and planets also forms an important component of the LEP research.

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Hardware is being delivered for the Composite Infrared Spectrometer and Plasma Spectrometer investigations on the Cassini mission to Saturn, and for the Mars Global Surveyor spacecraft.

A strong theoretical program exists which includes the study of solar wind turbulence, the modeling of the magnetosphere, the non-linear dynamics of the magnetosphere and the development of the next generation of adaptive grid MHD simulation codes.

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Astrochemistry

Keith W. Ogilvie
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Interplanetary Physics

L. Drake Deming
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Planetary Atmospheres, Infrared Spectroscopy & Molecular Structure

Steven A. Curtis
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Planetary Magnetospheres

James A. Slavin
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Electrodynamics

National Space Science Data Analysis Center — The center offers exceptional opportunities for computer scientists seeking to apply advanced data systems concepts to NASA's challenging space data problems. Areas of interest include on-line Data Base Management Systems, heterogeneous multisource data bases, transaction management, and data base logic.

Research is conducted on advanced data systems for scientific data management using expert systems, data base machines, mass storage systems and computer visualization, and on developing interactive scientific data systems integrating data archiving, catalogue, retrieval, data and image manipulation, and transmission techniques into distributed systems.

James Green
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Scientific Data Systems

Joseph King
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Mass Data Storage and Data Media

Greg Goucher
(301) 286-9884
Computer Visualization

Barry Jacobs
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Data Base Management

James Thieman
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Interoperable Information Systems

HPCC/Earth and Space Sciences (ESS) Project — Goddard is interested in research which will improve the usability and performance of distributed memory supercomputers. Areas of particular interest include parallel computational techniques, management of massive amounts of data, architecture independent programming, virtual environments. This work is in support of ESS Grand Challenge science applications, which include multi-disciplinary modeling of Earth and space phenomena, and analysis of data from remote sensing instruments.

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EARTH SCIENCES DIRECTORATE

The mission of the Earth Sciences Directorate is to provide leadership in achieving improved observations and understanding of global Earth systems processes and trends through the development and utilization of space technologies. The Earth systems being studied range from the deep interior (the core and the source of the magnetic field, the mantle, and its properties), through the surface (e.g., plate motion, soil formation, biospheric and hydrospheric processes, and ice studies), to the atmosphere (gaseous chemistry, trends, climate models), and beyond (the ionosphere, solar studies, and planetology). The Directorate keeps an aggressive basic and applied research program operating at a level which ensures strong vision and leadership while fulfilling its responsibilities encompassed by NASA and U.S. programs in Earth sciences.

Louis Walter
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Global Change Data Analysis Center — The Global Change Data Center (GCDC) provides Earth science data operations and archive management to key Earth science flight missions. The Center ensures that data within the archive are readily accessible through the Goddard Distributed Active Archive Center (GSFC/DAAC) and operates key advanced data systems to support NASA flight missions. The GCDC interacts closely with the scientific community being served.

The Goddard DAAC Facility is responsible for the acquisition, archiving, and dissemination of scientific data from specific Earth science missions. It develops, implements, and operates the GSFC/DAAC data system; interfaces the GSFC/DAAC with the other NASA DAAC systems in order to provide timely access to archived data and information; provides special services for the Earth science communities; performs scientific analysis; and generates multi-disciplinary data bases. It also oversees management of the archival systems and facilities of the GCDC; maintains the archive and preserves valuable information content against physical deterioration of the storage media; and produces a regular publication promoting and informing the science user community of its archive contents and services.

The Earth Science Data Operations Facility works closely with flight project personnel in data system planning and utilization, and develops and implements the capability to support Earth sciences mission needs. The Facility is responsible for supporting instrument algorithm development and operational project data set production systems; developing such systems for specific NASA flight projects such as the Earth Probes; and developing nationally accessible advanced data projects for the area of Earth science. It conducts research in advanced computer science methodologies for application to science data operations, and oversees management of the computer systems needed to process project data systems.

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Global Change Data Center

Paul Chan
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Goddard DAAC Facility

Richard Kiang
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Earth Science Data
Operations Facility

Laboratory for Atmospheres — This laboratory performs a comprehensive theoretical and experimental research program dedicated to advancing our knowledge and understanding of the atmospheres of the Earth and other planets. The research program is aimed at advancing our ability to predict the weather and climate of the Earth's atmosphere; advancing our understanding of the structure, dynamics, and radiative and chemical properties of the troposphere, stratosphere, mesosphere, and thermosphere; determining the role of natural and anthropogenic trace species on the ozone balance in the stratosphere; and advancing our understanding of the physical properties of the atmospheres and ionospheres of the Earth and other planets.

Franco Einaudi
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Tropical Rainfall Measuring Mission (TRMM) Office — This office is the focal point for the scientific planning and implementation of a Global Validation Program (GVP) supporting the Tropical Rainfall Measuring Mission (TRMM) satellite program. The TRMM Office mission also includes rain measurement technology research, precipitation processes studies, and development of methodologies for validating satellite measurements of rainfall.

Otto Thiele
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Data Assimilation Office — This office advances the state of the art of data assimilation and the use of data in a wide variety of Earth system problems. Develops global data sets that are physically and chemically consistent. The Office also provides operational support for NASA field missions and Space Shuttle science. Provides model-assimilated data set for the Mission to Planet Earth enterprises. Continual improvements are achieved by advancement of data assimilation and Earth-science modelling techniques.

Richard Rood
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Mesoscale Atmospheric Processes Branch — This branch studies the physics and dynamics of atmospheric processes through the use of satellite, aircraft and ground-based remote sensing observations and computer-based simulations. Development of advanced remote sensing instrumentation (primarily lidar) and techniques to measure meteorological parameters in the troposphere is an important focus. Key areas of investigation are cloud and precipitation systems from the scale of individual clouds and thunderstorms through mesoscale convective systems and cyclonic storms, and up to the scale of the impact of these systems on regional and global climate.

Robert Adler
(301) 286-9086

Climate and Radiation Branch — This branch conducts basic and applied research with the goal of improving the fundamental understanding of regional and global climate on a wide range of spatial and temporal scales. Emphasis is placed on the physical processes involving atmospheric radiation and dynamics with emphasis on processes leading to the formation of clouds and precipitation and their effects on the water and energy cycles of the Earth.

William Lau
(301) 286-7208

Atmospheric Experiment Branch
This branch carries out experimental investigations to further understanding of the formation and evolution of various solar system objects such as planets, their satellites, and comets. Investigations of the composition and structure of planetary atmospheres and also of the physical phenomena occurring in the Earth's upper atmosphere are carried out. Neutral and ion mass spectrometers are developed to measure atmospheric gasses from entry probes and orbiting satellites.

Hasso Niemann
(301) 286-8706

Atmospheric Chemistry and Dynamics Branch — This branch performs measurements and research to increase understanding of the behavior of stratospheric ozone and trace gasses that influence ozone. Designs and develops models of the atmospheric chemical system to test theories and provide predictions of the impact of trace gas emissions on the ozone layer.

Mark Schoeberl
(301) 286-5819

Laboratory for Terrestrial Physics — The Laboratory for Terrestrial Physics (LTP) advances the scientific knowledge of the Earth and planetary solid-body physics. In the scientific branches, research is pursued on the distribution of mass within the Earth-ocean-atmosphere system, the origin of the Earth's magnetic field, the nature of the movement of the tectonic plates which form the Earth's crust, the effect of variation in the momentum of the atmosphere and changes in the hydrosphere on the Earth's rotation rate, the role of vegetation in the carbon cycle, the most efficient dataset required to detect and interpret change at the ecosystem level, and the nature of the interior structure of the Moon, Mars and Venus. The Laboratory has a significant capability to design, develop and test laser and electro-optic remote sensing instruments. The LTP has designed and managed several spacecraft instruments.

David Smith
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See http://ltpwww.gsfc.nasa.gov

Geodynamics — Research topics include the structure and composition of the Earth's interior through geodetic studies of the gravity and magnetic fields, the study of the lithosphere through magnetic anomalies, the rotational parameters of the Earth and planets, the measurement of topography with altimeters and the study of planetary landforms.

Herbert Frey
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Terrestrial Information Systems
Advances research programs and institutional administrative activities through research in and applications of information technology. Activities include development of data systems to process and distribute information from Earth observing satellites, aircraft sensors, ground-based networks and field experiments, develop software for visualization, analysis, and presentation of scientific data.

Edward Masuoka
(301) 286-7608

Biospheric Studies — These include research on terrestrial ecosystem-atmosphere interactions, and ecological patterns and processes occurring at local, regional and continental spatial scales, as well as basic remote sensing research. A wide variety of remote sensing models and passive and active instruments are used to develop a fundamental understanding of the interaction of electromagnetic radiation with terrestrial surfaces. Laboratory, field, aircraft, and satellite investigations are used to characterize the spectral distribution, bi-directional reflectance, and polarization response of terrain features at visible, infrared and microwave frequencies. Techniques are developed to create, process, and analyze multi-year global datasets. Time series of satellite data are used to study the seasonal dynamics of global vegetation, interannual variations in production of semi-arid grasslands, tropical forest alteration, and to provide improved surface characterization for input into global models.

Darrel Williams
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Laser Instruments — Designs and develops advanced electro-optic and laser sensors for ground-based, airborne and spaceborne Earth and planetary science investigations. Work includes laser and detector research, sensor development research and conceptual design, performance calculations, sensor engineering and fabrication, as well as calibration and integration. Sensors are used for measurements of Earth and planetary surfaces and of the Earth's atmosphere and oceans. The branch also develops advanced laser sensors, including laser altimeters and lidar systems, for airborne and spaceborne use.

James Abshire
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Space Geodesy — Research uses precise geodetic methods, including laser ranging and very long baseline interferometry, altimetry, data from highly accurate tracking systems such as GPS and doppler, gradiometry and satellite-to-satellite tracking to measure and study the motion of the Earth on its axis, the kinematics of plate motion, the deformation of the crust, the Earth and ocean tides, variations in sea level, and models of the gravity fields of the Earth and planets.

John Bosworth
(301) 286-7052

Laboratory for Hydrospheric Process — The Laboratory performs theoretical and experimental research on various components of hydrology and its role in the complete Earth system. The program is aimed at observing, understanding, and modeling the global oceans and ice, surface water, and mesoscale atmospheric processes. The Laboratory conducts research on Earth observational systems and techniques associated with remote and in-situ sensing.

Antonio Busalacchi
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Oceans and Ice Branch — This Branch conducts oceans and ice research to enhance understanding of these systems and their relationships with other elements of the Earth's climate. Research focuses on problems in biological, physical, and polar oceanography; glaciology; and marginal ice zones, air-sea interactions, and coupled climate modeling. Pursues interdisciplinary studies on problems such as those involving productivity and carbon fluxes, upper ocean and thermohaline circulation of the oceans; ice/ocean coupling; and ice sheet dynamics are conducted.

Chester Koblinsky
(301) 286-4718

Observational Science Branch (Wallops Island, VA) — This Branch conducts theoretical and experimental research on observational systems and techniques for oceanic remote sensing. Develops and operates research facilities (i.e., wave tank, laboratory field standards, aircraft remote sensors), ground-based ozone and wind sensors to obtain scientific data and develop new sensors.

Dave Clem
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Hydrological Sciences Branch — The Hydrological Sciences Branch conducts research activities which contribute to an improved understanding of the exchange of water between the Earth's surface and its atmosphere. These research activities emphasize the use of remote sensing over a wide range of electromagnetic frequencies as a means of studying various hydrological processes and states, such as precipitation, evapotranspiration, soil moisture, snow and ice cover, and fluxes of moisture and energy. In addition, advanced numerical and analytical models are developed.

E. Engman
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Microwave Sensors Branch — This Branch performs research and development on advanced microwave sensing systems and data collection systems directed at providing remote and in situ data for research in the areas of the oceans, ecology, weather, climate, and hydrology. Performs basic theoretical , laboratory and field studies that elucidate the interaction of electromagnetic radiation with the environment to improve our understanding of remote sensing systems. Branch members contribute to the development of microwave science and engineering for the Tropical Rainfall Measurement Mission (TRMM), the

Earth Observing System (EOS), and various airborne campaigns.

Les Thompson
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SeaWiFS Project — The Sea-viewing Wide-Field-of-view Sensor (SeaWiFS), to be launched on Orbital Sciences Corporation's SeaStar satellite in early to mid 1997, will provide global observations of ocean color for NASA. These data will be used to assess phytoplankton abundance, ocean productivity, and the ocean's role in the global carbon cycle. In addition, the observations will help visualize ocean dynamics and the relationships between ocean physics and large-scale patterns of productivity.

Charles McClain
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Earth and Space Data Computing Division — The Earth and Space Data Computing Division (ESDCD) enables NASA-supported scientists to increase their understanding of Earth and its environment, the Solar System, and the Universe through the computational use of space-borne observations and computer modeling.

The ESDCD manages and operates the NASA Center for Computational Sciences (NCCS), a primary supercomputing and data storage center for support of NASA missions and programs. The ESDCD utilizes state-of-the-art computational equipment and data systems to provide end-to-end support of computational research conducted by the Earth and Space Sciences Directorates at GSFC and to a somewhat lesser extent external NASA approved research investigators. Specifically, the ESDCD meets its science-driven requirements by providing specialized computational processing and archival services for approved projects and individual scientists as well. In addition, the ESDCD provides support in the areas of sensor algorithms for direct ground communications readout of satellite transmissions, information processing, discipline data base management systems, high performance computing and parallel processing, high speed local and wide area network support, and advanced science data visualizations systems.

The NCCS engages in the application of advanced computer system architectures, such as the CRAY J932, and massively parallel machines such as the MASPAR MP-2, to support complex computational physics modeling efforts. These modeling efforts involve, for example, studies of coupled multi-dimensional ocean and atmospheric systems, multi-dimensional magnetospheric-ionospheric systems, and astrophysical processes. Specific research opportunities exist for development of new numerical algorithms in computational physics that utilize advanced computer architectures, development of advanced scientific visualization, algorithms for visualization of space and Earth science processes, and the development of advanced techniques for managing decaterabyte mass data storage and delivery systems.

Jan M. Hollis
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GODDARD INSTITUTE FOR SPACE STUDIES (NEW YORK, NY)

The Goddard Institute for Space Studies conducts comprehensive theoretical and experimental research programs in four major areas.

Planetary Atmospheres — Concerned with investigations of Jupiter, Saturn, Venus, and the Earth. The observational phase of the program includes imaging and polarization measurements from the Pioneer Venus Orbiter and radiation-budget, temperature-sounding, photometric, and polarization measurements from the Galileo Jupiter Orbiter. The theoretical phase of the program includes interpretation of radiation measurements of planets to deduce bulk atmospheric composition and the nature and distribution of clouds and aerosols, and analytical and numerical models of planetary circulations. Emphasis in the theoretical program is on analysis of physical processes in terms of general principles and models applicable to all planets.

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Anthony Del Genio
(212) 678-5588
Atmospheric Dynamics

Larry Travis
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Barbara Carlson
(212) 678-5538
Radiative Transfer

Goddard Space Flight Center

Causes of Long-Term Climate Change — Basic research on the nature of climate change and climatic processes, including the development of numerical climate models. Primary emphasis is on decadal or end-of-century global-scale simulations, including studies of humanity's potential impact on the climate. Climate sensitivity and mechanisms of climatic change are investigated in global paleoclimatic research. In addition to their use for climate simulations, the global models are used to simulate the transport of atmospheric constituents and thus study their global geochemical cycles. The program also includes development of techniques to infer global cloud, aerosol and surface properties from satellite-radiance measurements as part of the International Satellite Cloud Climatology Project and the Earth Observing system and analysis of the role of clouds in climate.

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Convection and Clouds

James Hansen
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Greenhouse Effect

Dorothy Peteet
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Paleoclimate, Pollen Studies

David Rind
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Climate Dynamics, Stratosphere

William Rossow
(212) 678-5567
Global Cloud Properties

Andrew Lacis
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Radiative Processes

Biogeochemical Cycles — Research on global biogeochemical cycles involving the study of chemically and radiatively important trace gases. The aim is to improve our understanding of the cycles of CO_2, CH_4, N_2O, CFCs, O_3, NO_X, OH, and other trace compounds which are expected to affect climate and air quality in the near future. The research involves three-dimensional chemical tracer models, which are essential for determining the sources and sinks of these gases and for predicting future atmospheric composition. Central to the program is the investigation of the role of the biosphere, terrestrial and oceanic, in the global carbon cycle using a combination of satellite measurements and modeling.

Inez Fung
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Carbon Cycle, Ocean Modeling

Interdisciplinary Research — Interdisciplinary research ranges from theoretical studies of the origin of the solar system to relationships between the Sun, terrestrial climate, geological processes, and biology. One phase of the program involves the structure and evolution of accretion disks, especially the primitive solar nebula, using models of large-scale turbulence. Another area concerns the evolution and pulsation of bright stars, which may be analogs of the Sun. A biological question of special interest concerns how terrestrial vegetation will change during the next 50 years, when climate and atmospheric CO_2 are expected to be changing.

Vittorio Canuto
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Turbulence

Richard Stothers
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Stars, Climate Studies

Dorothy Peteet
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Biology

Cynthia Rosenzweig
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Agronomy, Climate Impacts

ENGINEERING DIRECTORATE

The Engineering Directorate supports NASA Space and Earth Sciences and application programs through technical research and development. The Directorates enabling technology program increases knowledge and capabilities in areas necessary for the success of assigned NASA missions. The design, development and test of components, subsystems, instruments and spacecraft for multiple programs and projects is an important part of the mission of the Engineering Directorate. The Engineering Directorate oversees the in-house development of flight hardware and software including instruments, Attached Shuttle Payloads, and Small Explorer Spacecraft, and provides system and discipline engineering support for space and Earth Science missions such as the Hubble Space Telescope and Earth Observing System.

Michael Fitzmaurice
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Goddard Space Flight Center

Thermal Development Laboratory — This laboratory is responsible for the development of new thermal control technology for future NASA spacecraft. Current work efforts focus on such technologies as cryogenic heat pipes. two-phase capillary pumped loops, and heat pumps. The scope of the work encompasses concept development, breadboard to prototype testing, conduction of flight experiments, and analysis. The 7000 square foot laboratory/office area has numerous test loops. These range in size from small benchtop units to an 8 ft. by 30 ft. facility, which is the largest known modular two-phase test bed. A wide variety of instrumentation, data collection/processing, and other support equipment are available to support these testing efforts.

Theodore Swanson
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Optics Laboratory/Electro-Optics Laboratory — The Optics Branch conducts research and development programs in the optical sciences and engineering to support flight experiment development in the areas of high energy astrophysics, solar and stellar astronomy, atmospheric sciences, and ocean and terrestrial sciences. Specific research and development objectives include optical property characterization of solids and thin films, diffraction grating technology, optical system design and analysis, and advanced optical fabrication and testing. Modern laboratory facilities are equipped for optical property studies in the far-infrared to extreme ultraviolet, generation of holographic diffraction gratings, and optical fabrication and testing. In addition, extensive computer facilities are available to support optical design and analysis studies.

The Electro-Optics Laboratory conducts applied research in electro-optics including high power semiconductor lasers, diode pumped solid state lasers, photo refractive filters, acousto-optic tunable filters, Fourier transform interferometers and photon counting detectors for remote sensing instruments. A major thrust is the investigation of the use of laser diodes as the transmitter source for active remote sensing instruments. Both the physics and engineering aspects of these systems are under investigation. Instrumentation is being developed and demonstrated for ground-based and flight observational research from ultraviolet to infrared wavelengths.

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Ritva Keski-Kuha
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Michael Krainak
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David Glenar
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Electromechanical Systems Branch — Develops mechanical, optomechanical, and electromechanical systems required to support flight instrument and spacecraft projects. Conducts advanced and supporting research and development efforts to support new technology, such as magnetic bearings and cryogenic mechanisms, applicable to existing and future spaceflight requirements. Deployable appendages such as magnetometer booms and 100 meter long electric field antennas are developed. Flight structures ranging in size from small optical benches to instruments weighing several tons are provided. Electromechanical systems and their control electronics are developed, taking into account the effect of spacecraft structural disturbances (jitter) where applicable. Modern laboratory facilities are equipped for electromechanical fabrication and testing.

Mike Hagopian
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Willie Blanco
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Cryogenics Laboratory — This laboratory conducts research and development programs in low temperature physics in support of astrophysics goals. General research objectives are the development of low temperature microcalorimeters for the detection and imaging of charged particles and radiation, and high-precision and high-accuracy thermometry. Current research focuses on detectors and sensors using thin-film superconductors. This includes the development of detectors using tunnel junctions to obtain energy and/or spatial resolution, kinetic inductance calorimeters, and thermometry using superconductors. Modern laboratory facilities are equipped for detector characterization, including cryogenic workstations with automated data collection, SQUID systems, dilution and adiabatic demagnetization refrigerators, and facilities for evaporation and sputtering of thin films.

Stephen Castles
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Goddard Space Flight Center

Mechanical Engineering Branch
The Mechanical Engineering Branch performs structural and mechanical design for in-house STS and ELV launched spacecraft, instruments, and mechanical ground support equipment. These designs include spacecraft and instrument primary and secondary structures; deployable appendages such as solar arrays and antennas; flight mechanisms such as actuators, hinges and release mechanisms; and mechanical ground support equipment such as lift slings, dollies, containers, and g-negation hardware. The Branch also provides support for fabrication, assembly, integration, and testing of spacecraft and instrument structures including structural design research and design optimization of advanced composite materials. The Branch performs structural analyses in support of flight hardware design and testing and provides advanced development for maintaining state-of-the-art CAD/CAM technology.

James Ryan
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Gary Jones
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Mechanical Systems Division

Detector Development Laboratory — The Solid State Device Development Branch is responsible for the research and development of sensors and semiconductor devices in support of NASA's spaceflight programs. The major branch facility is the Detector Development Laboratory (DDL), and it has the capability of designing and fabricating advanced X-ray detectors, silicon circuitry, advanced monolithic infrared detectors and a myriad of new and innovative electronic devices.

The DDL is a class 100 cleanroom of 4,389 square feet surrounded by a 3,669 square foot class 10,000 service area. The class 100 area is vibration controlled and will house the following operations: Chemical Vapor Deposition, Vacuum deposition, Ion Implantation, Photolithography, Wet Chemistry, Atmospheric Furnaces, Dry Etch and Test/Evaluation. This is supported by a complete CAD facility that enables our engineers to design, fabricate, and test all the products in the branch.

Peter Shu
(301) 286-8006

Flight Data Systems Branch — The Flight Data Systems Branch develops new technologies for satellite on-orbit data processing, then designs, builds and tests data systems using these technologies for in house and out of house GSFC programs. The Flight Data Systems Branch has provided hardware and software multiprocessor flight data systems for SAMPEX, HST, XTE, SSTI/Lewis, and TRMM. The Branch also provides support to GSFC programs in the area of radiation, performing orbit analysis, and candidate parts testing, performing heavy ion, proton and total dose testing. Current focuses are the development of radiation hardened 32-bit processors, ultra high speed fiber optics networks, and distributed computing architectures. Laboratory facilities include multiple workstations where digital designs are entered and simulated prior to fabrication. Special test equipment is designed and fabricated for radiation testing of candidate parts prior to their inclusion in a flight data system design. Functional testing of electronics printed circuit boards is performed, followed by integration of a completed data system box. Flight software integration and validation is performed and continues through launch.

Dennis Andrucyk
(301) 286-5659

MISSION OPERATIONS AND DATA SYSTEMS DIRECTORATE

The Mission Operations and Data Systems Directorate is responsible for the following: (1) planning, design, development, and operation of spaceflight tracking and communications networks and data systems support of near-earth spaceflight missions; (2) activities in mission planning, mission analysis, space and ground network operations, spacecraft and payload command and control, flight dynamics, information processing, and flight mission operations; (3) planning and applied research development of advanced data systems and telecommunications systems in support of spaceflight missions; and (4) ensuring that space and ground communications network, mission analysis and support computing capabilities, and end-to-end data systems meet mission support requirements and are maintained at the state of the art.

Donald Wilson
(301) 286-7550
New Technology and Data Standards Manager

Goddard Space Flight Center

Data Systems Technology Division
The Data Systems Technology Division develops and applies systems, hardware, and software technologies to support complex command and control, communications, and telemetry data processing requirements of future space missions. The division performs advanced technology development in high performance VLSI systems for telemetry processing, high data rate/volume data storage architectures, distributed systems and networks, software engineering, human-machine interface technology, and artificial intelligence-primarily in the areas of knowledge-based, model-based, and agent-based systems; planning and scheduling; and monitoring and control. Joint projects are formed with other Goddard organizations to transfer technology from the laboratory into operational systems through the development of test beds and advanced operational prototypes. Application projects include VLSI-based telemetry front end processors and workstations, a computer-aided systems engineering support environment, an advanced user interface design and development environment (TAE Plus), an agent technology test bed, and a prototype self-organizing network for distributed telemetry systems. Division laboratory facilities provide some of the most advanced systems design and development capabilities available, including a complete suite of VLSI design tools, libraries, and workstations; advanced commercial parallel disk farms; VME & PCI components for system integration; workstations from SUN, HP, DEC, IBM, Silicon Graphics, and NEXT; advanced tools for systems and software engineering, modeling, and human-computer interface design; and expert systems shells and development environments.

Nicholas Speciale
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VLSI systems

Sylvia Sheppard
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Human-Machine Interfaces
Computer Aided
Systems Engineering

Julia Breed
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Software Engineering

Walt Truszkowski
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Artificial Intelligence

Flight Mechanics Branch — The Flight Mechanics Branch (FMB) provides various support functions to the flight projects, tracking networks and scientists throughout a mission's lifetime. The FMB provides these functions from the early mission support of analyzing mission requirements and the development of ground determination systems that will be used for launch and normal operations, to the normal operations activities of producing mission planning products and verification of attitude and orbit performance.

The FMB analysis process is divided into three major areas of technical expertise. The attitude determination and control, the orbit determination, mission design and control, and the vehicle and network areas. The attitude determination and control area is responsible for the analysis, operational support and verification of the mission's attitude estimation and pointing, and the on-board sensors related to attitude determination. The orbit determination, mission design and control area is responsible for the analysis, operational support and verification of the mission's navigation systems and orbital trajectories. The vehicle and network area is responsible for planning, analysis and operational support for Space Shuttle acquisition data, expendable launch vehicle trajectory definition, and system engineering and tracking data evaluation for NASA and NASA affiliated networks. Representatives from these three areas work closely with the Project Office, scientists, tracking networks, and the spacecraft manufacturer to ensure that all requirements are met to provide for a nominal mission. All three areas support advanced research for the analysis and algorithm development of new and innovative operations support.

Thomas Stengle
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SUBORBITAL PROJECTS AND OPERATIONS DIRECTORATE — WALLOPS FLIGHT FACILITY (WALLOPS ISLAND, VA)

The Suborbital Projects and Operations Directorate's (SPOD) mission is to provide support to the scientific community through frequent rocket, balloon, and aircraft flight opportunities. The major activities conducted by the Directorate are:

Sounding Rocket Program — This program provides "cradle to grave" support to an investigator by designing and analyzing a mission to meet the science requirements; designing, fabricating, and testing the spacecraft; and integrating the spacecraft with a suborbital rocket system, providing project management and launch operations from a variety of launch locations, and providing the reduced data to the scientist.

Balloon Program — This program provides the science community with access to the upper atmosphere for extended durations from a variety of launch locations. The projects are conducted by a contractor at the National Scientific Balloon Facility in Palestine, Texas. The SPOD manages the overall program and performs research and development activities.

Aircraft Program — This program utilizes aircraft as a platform to carry scientific payloads to lower altitudes than the Sounding Rocket and Balloon programs. In addition to aircraft operations and maintenance, the SPOD provides project management and engineering necessary to conduct scientific measurements including the integration of experiments on aircraft and modifications of aircraft structures. The program also operates a launch range support aircraft and an administrative aircraft.

Launch Range — In support of NASA's rocket launching requirements, the SPOD maintains and operates a launch range. This support includes project management, telemetry and radar tracking, communications, range safety, ordnance handling, data reduction, and other support services necessary to a range user. In support of these activities, the SPOD provides numerous facilities including a Range Control Center, assembly and storage facilities, blockhouses, and rocket launchers. The launch range also supports numerous other users including DoD and commercial customers. The SPOD also operates a complete mobile launch range capable of supporting rocket launches throughout the world.

Research Airport — The WFF airport serves the dual role of providing a home to the SPOD and visiting aircraft and also to support aeronautical research. The airport has numerous characteristics including textured surfaces, a water ingestion testing pit, calibration points, arresting gear, and the ability to utilize radar and telemetry ground systems for data acquisition.

Orbital Tracking — The SPOD provides ground station support for more than a dozen of NASA's low-earth orbiting satellites at WFF. Additionally, it provides mobile orbital tracking support at various locations throughout the world. Presently, there are substantial engineering efforts ongoing in this area which will lead to highly automated ground stations.

B. Underwood
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Office of Policy and External Relations

Jet Propulsion Laboratory

Pasadena, CA

The primary role of the Jet Propulsion Laboratory (JPL) within NASA is the exploration of the solar system, including planet Earth, by means of unmanned, autonomous spacecraft, and instruments.

JPL scientists, technologists and engineers engaged in Earth atmosphere and geosciences, oceanography, planetary studies (including asteroid and comet), and solar, interplanetary, interstellar, and astrophysical disciplines. Opportunities for Graduate Student Researchers exist in all technical divisions of JPL. These technical divisions, encompass almost all JPL engineering and science resources. Each technical division is concerned with the planning, design, development engineering, and implementation functions relevant to its discipline area. Fundamental to the structure of JPL is the cooperation among the research, science and advanced technology, and the engineering functions of these operating divisions.

Program Administrators:

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SYSTEMS DIVISION

The Systems Division performs systems engineering and design integration for all the major projects undertaken by JPL. It also conducts specialized analyses in many disciplines to support these projects.

Mission Design — Includes interplanetary spacecraft trajectory design, planning mission timelines to accommodate science requirements, launch vehicle trajectory analysis, studies of advanced interplanetary scientific missions, and software development to support mission design and analysis.

Spacecraft Systems Engineering Supports JPL flight projects by providing design integration of the total spacecraft system, including its interfaces with the launch vehicle and with its scientific instrument payload. It also conducts studies and analyses of advanced future spacecraft designs and analyzes the performance of spacecraft in flight.

Navigation Systems — Develops the capability to determine very precisely the position and velocity of scientific spacecraft in interplanetary space through radiometric and optical techniques, designs propulsive maneuvers to place spacecraft on correct trajectories, develops complex software to solve the equations of motion, and conducts scientific studies of relativistic gravity, planetary orbital dynamics gravitational radiation and planetary masses and gravity fields using spacecraft radio tracking data.

Mission Profile and Sequencing — Develops the detailed sequences to be executed by interplanetary spacecraft, plans the commands required to carry out the sequences, and develops the software that keeps track of the command sequences and ensures the commands will safely perform the desired functions. Provides support to science activity development and implementation. Conducts research related to planning and sequencing software technology.

Project Test and Operations — Performs planning, management and performance of test, integration and launch activities for major systems, including spacecraft, science instruments, ground data systems and ground support equipment. Conducts research and development for integration and test technologies and operates and manages JPL's major Spacecraft Assembly Facility.

Mission Information Systems Engineering — Supports JPL flight projects in the development of plans for the operation of interplanetary spacecraft in flight. This involves design of the end-to-end data system from the spacecraft instrument to the scientist receiving the data, as well as design of ground-based systems of hardware, software, and terms used to control the spacecraft and process the data.

Systems Analysis — Performs economics, operations research, costing, and mission analyses for a broad spectrum of unmanned and manned space projects and military and civilian ground-based programs.

Technology and Applications Systems Engineering — Performs system level design, integration, and development of information systems, including computer hardware and software and large distributed near real time ground data processing. Disciplines include traditional electrical, mechanical, aeronautical, and aerospace engineering, along with computer science, operations research, economics, and the physical sciences.

Kent Frewing
(8l8) 354-6780

EARTH AND SPACE SCIENCES DIVISION

The Division conducts a wide-ranging program of research in oceanography, the atmospheres and solid bodies of Earth and other planets, planetary satellites, asteroids, comets, interplanetary medium, and selected solar, stellar, and interstellar phenomena. Ground-based observations, aircraft, balloons, and Earth-orbiting and planetary spacecraft are utilized. Extensive laboratory and theoretical research efforts, data analysis, interpretation, and modeling support these observational programs.

Clifford Heindl
(818) 354-4603

Oceanography — Altimetry for determining currents and tides; air-sea interactions including, fluxes of mass, momentum, energy, and chemicals between ocean and atmosphere; determination of marine biomass and ocean productivity; sea ice dynamics and influence on climate variability; global surface temperature measurements; surface driving forces and wave propagation derived from radar observations.

Lee-Leung Fu
(818) 354-8167

Earth Atmosphere — Laboratory research, field measurements, and data analysis to understand the chemistry of stratospheric ozone; monitoring of long-term trends in important minor and trace constituents; extraction of meteorological parameters from satellite data, including temperature profiles, humidity, clouds, winds, and pressure.

James Margitan
(818) 354-2170

Planetary Atmospheres — Observations from ground-based telescopes and analysis of spacecraft data to determine composition, structure, and dynamics; long-term study of seasonal and inter-annual variability; global mapping; synthesis of information to determine physical processes and state of the atmospheres.

Jay Goguen
(818) 354-8748

Earth Geoscience — Characterization of exposed rocks, sediments, and soils on the Earth's surface to understand the evolution of the continents; examination of the state and dynamics of biological land cover for assessment of the role of biota in global processes; tectonic plate motion; volcanology; paleoclimatology.

Ronald Blom
(818) 354-4681

Planetology — Observations of the surface of the inner planets, the satellites and rings of the outer planets, asteroids and comets across the spectral range from ultraviolet through active and passive microwave; studies of meteorites and cosmic dust; theory and modeling relevant to the origin and evolution of the solid bodies of the solar system; development of approaches to the detection and characterization of solar systems around other stars.

Bruce Banerdt
(818) 354-5413

Space Physics — Mapping of the magnetic fields of the Sun and planets and their time variations; structure and dynamics of the solar wind; interactions of solar fields and particles with the magnetic fields and outer atmospheres of Earth and planets.

Marcia Neugebauer
(818) 354-2005

Astrophysics — Sky survey of infrared sources; composition and chemistry of interstellar clouds; identification of gamma-ray sources within the galaxy and beyond; observations of supernova 1987A; studies of gravitational wave detection utilizing spacecraft.

Michael Janssen
(818) 354-7247

TELECOMMUNICATIONS SCIENCE AND ENGINEERING DIVISION

Astrophysics — Observational and theoretical research into the nature of radio emissions from quasars, galaxies, and stars.

Jet Propulsion Laboratory

Robert Preston
(818) 354-6895

Planetary Atmospheres and Interplanetary Media — Experimental and theoretical research investigations based on the use of spacecraft radio signals to probe planetary atmospheres and the interplanetary/solar plasma.

Richard Woo
(818) 354-3945

Planetary Dynamics — Determination of orbital, rotational, or atmospheric motions of planets by tracking of spacecraft or balloons associated with the planets.

Robert Preston
(818) 354-6895

Asteroid Dynamics — Study orbital evolution of main belt and planet crossing asteroids, resonances, and asteroid families.

James Williams
(818) 354-0866

Geodynamics — Experimental and theoretical investigations of global and regional phenomena using the modern space geodetic techniques of lunar laser ranging, Very Long Baseline Interferometry (VLBI) and the Global Positioning System (GPS).

Jean Dickey
(8l8) 354-3235

Information Theory and Coding
Theoretical research into information theory, channel and source coding with special emphasis on very noisy channels. Smaller interest in communication theory, detection and estimation of weak symbols, bandlimited channels, and fading channels.

Fabrizio Pollara
(818) 354-4287

Optical Communication —
Theoretical and experimental research involving free space laser communications systems, components, and techniques, and including such items as lasers, detectors, modulators, signal design, large telescope design, spatial and temporal acquisition and tracking, detection strategies, and channel coding.

James Lesh
(818) 354-2766

Frequency Standards Research
Experimental investigations in the area of quantum electronics and quantum optics, including ion and atom trapping and tooling, for the development of ultra-stable sources of microwave and optical reference frequencies.

Lute Maleki
(818) 354-3688

Planetary Radar Astronomy —
Experimental and theoretical research in planetary surfaces, atmospheres, and rings (including geology, spin dynamics, and scattering properties of rings and cometary debris swarms) using the ground-based Goldstone radar system, the Very Large Array, and Arecibo Observatory to form images of terrestrial planets, asteroids, and comets.

Martin Slade
(818) 354-2765

Radar Remote Sensing of the Earth — Experimental and theoretical investigations in remote observation of the Earth's surface through radar scattering properties, for example, polarization and interferometry to determine the structure and motion of regions of interest.

Jakob Van Zyl
(818) 354-1365

Microwave Antenna Holography
Experimental and theoretical research in microwave anteanna holography and related topics. These include: phase retrieval, prescription retrieval, antenna design and optimization techniques, and advanced development of antenna measurement and instrumentation.

David Rochblatt
(818) 354-3516

Atmospheric Remote Sensing —
Experimental and theoretical investigations of water vapor in the Earth's atmosphere. Emphasis on providing active calibration of the delay imposed on radio and optical remote sensing techniques.

George M. Resch
(818) 354-2789

AVIONIC SYSTEMS AND TECHNOLOGY DIVISION

Formation Flying of Multiple Spacecraft — Research in optical and RF formation flying sensors, controls, control and software architecture, simulations, testbeds, along with integration and testing for multiple spacecraft formations (including rendezvous and docking) in Earth orbit and deep space.

Jet Propulsion Laboratory

Technologies must be usable by a wide variety of future missions.

Kenneth Lau
(818) 354-9749

Interferometer Technologies — Develop and design high fidelity optical and structural components to be incorporated into a multi-disciplinary modeling tool (thermal, structures, controls and optics). Extremely high number of interferometer actuators and sensors requires innovative high bandwidth controls, along with fault detection and response strategies. Integration of autonomous calibration and alignment of optics for interferometers in space. Design optimal maneuvers for monolithic and separate spacecraft interferometers.

Kenneth Lau
(818) 354-9749

Control of Inflatable Antennas — Research in modeling, pointing control, vibration control, and shape control of large, inflatable antennas. Analysis and control of optical/RF performance and structural dynamics.

Sam Sirlin
(818) 354-8484

Autonomous Control Systems — Development of advanced control methods and concepts for autonomous spacecraft stabilization, pointing and tracking. Integration of miniature/feature trackers, gyros and advanced metrology systems. In-flight identification, estimation and control strategies for space interferometers. Development of a new generation of control design, modeling, and simulation tools.

David Bayard
(818) 345-8208

Spacecraft Autonomy — Architecture to facilitate robust and testable fully autonomous spacecraft. Autonomous position determination, autonomous guidance laws, autonomous attitude maneuvers, autonomous target acquisition and tracking, autonomous spacecraft resource management, autonomous fault detection, isolation, and recovery. Fully autonomous guidance, navigation, and control of interplanetary spacecraft propelled by ion propulsion systems.

Doug Bernard
(818) 354-2597

Advanced Spacecraft Control Systems — System architectures, sensors, actuators, and algorithms for autonomous rendezvous, docking, aerobraking, and landing. Development of concepts to enable high bandwidth control of flexible space structures and to provide active space control.

Tooraj Kia
(818) 354-5165

Electro-optical Tracking Systems Development and testing of electro-optical sensors and algorithms for star, limb, and target-feature tracking. Development of interferometric metrology sensors and systems.

Randy Bartman
(818) 354-5320

Electric Power Research and Engineering — Development of lightweight, high-power fuel cells; high efficiency thermal-to-electric conversion; high-efficiency photovoltaic conversion; high energy batteries; and high-density power microelectronics.

Perry Bankston
(818) 354-6793

Flight Microelectronics System — Research and development of advanced microelectronics computing and avionics systems technologies, including: Semiconductor technologies for scaled voltage, power, and feature size; Ultra Low Power devices, architectures, and systems; Radiation Tolerant electronics, architectures and systems design; Advanced flight computer design, performance modeling, benchmarking and evaluation; Memory systems for both volatile and non-volatile storage (SRAM/DRAM/Flash, Holographic storage, etc.); Low Power I/O architectures; high-speed interconnect networks; commercial off the shelf architectures for low-cost system applications; Fault Tolerant systems, including hardware and software fault-tolerance using off-the-shelf components; Modeling and analysis of FT systems. Design Automation techniques for Design for Testability and Built In Self Test; Advanced Microelectronics Packaging, such as chip stacking in 3D, MCMS, and MCM stacking in 3D; Collaborative engineering, integration and testing.

Leon Alkalai
(818) 354-5988

Advanced Multi-Mode Avionic Design — Development of advanced designs that incorporate analog/digital optoelectronics and/or RF on one substrate. Development of the design tools necessary for such devices. Development of specific avionic equipment utilizing such devices (I/O interfaces, switching circuitry, etc.).

John Klein
(818) 354-2603

Precision Mechanisms and Motion Sensing — Innovative devices for rotation and displacing optical components to high precision and at high bandwidth (e.g., for active and adaptive optics and optical interferometry), and devices for sensing such motion.

Ted Iskenderian
(818) 354-2972

Autonomous Mobile Vehicles — Real-time path planning in uncertain terrains; locomotion and mobility, computer vision for rover control, and combined mobility and manipulation.

Brian Wilcox
(818) 354-4625

Robot Arm Control — Research in advanced manipulator control, adaptive arm control, control of redundant arms, cooperative dual-arm control, force and impedance control, motion planning and control of robotic vehicles, robot control architectures, task-level control, sensor-based motion planning and control, intelligent control of robots.

Homayoun Seraji
(818) 354-4839

Robotics Man-Machine Systems
Development of controls, sensing, manual and graphics-based user interfaces for telerobotic operations and telepresence. Applications to robotic space servicing and exploration and medical robotics.

Homayoun Seraji
(818) 354-4839

Data Storage Technology — Investigation of hybrid magnetic-semiconductor memory devices for the development of memory and data storage modules for space applications. Development of design, simulation, and experimental capabilities to validate technologies including Bloch Line and magneto resistance-based devices for space data storage applications. Investigation of magneto-optical and optical data storage technologies, including holographic data storage, for space mass-storage applications.

Romney Katti
(818) 354-3054

Magnetic Device Technology — Investigation of magnetic devices such as microinductors, microtransformers, and magnetically actuated devices for space applications.

Romney Katti
(818) 354-3054

Multi-mission Spacecraft Avionics Core — Develop and design an avionics core for instruments and interplanetary spacecraft. Establish requirements and minimum core architecture that is scaleable. Architecture must allow reuse of software, documentation and development tools across multiple missions.

Tooraj Kia
(818) 354-5165

GPS Based Attitude Determination — Performance improvement through active multipath suppression, passive multipath mitigation (e.g., configuration rules, RF absorbing materials) and lower noise amplifiers. Autonomous attitude initialization algorithms).

Kenneth Lau
(818) 354-9749

Machine Vision Systems — Development of algorithms for visual shape and motion estimation, object recognition, and pose estimation for applications in space flight and planetary exploration. Such applications include autonomous rendezvous and docking, autonomous landing, robotic maintenance of earth- orbiting spacecraft, and planetary rovers. Also interested in development of advanced imagers and high performance, low power, onboard computing hardware for these applications

Larry Matthies
(818) 354-3722

Neural Network Algorithms — Advanced neural algorithms for Spacecraft Control, autonomous rendezvous, docking, and landing. Development of Feature extraction and tracking algorithms for small body spin vector and shape estimation. Application of neural networks to multi-sensor integration.

Benny Toomarian
(818) 354-7945

Concurrent Processing Devices and Neural Network Hardware — Research and technology development in architectures and hardware implementable algorithms related to neural networks, fuzzy logic, genetic algorithms, cellular automata, and other VLSI-based analog and digital concurrent processing devices.

Taher Daud
(818) 354-5782

MECHANICAL SYSTEMS DIVISION

The Mechanical Systems Division carries out research in propulsion, cryogenics, structures, mechanical systems, materials, and thermal sciences. Research opportunities exist in materials with unique electro-mechanical and optical properties, active control of structural shape and vibration, inflatable structures, chemical sensors, cryogenic cooling systems including sorption coolers and integration of mechanical coolers with instruments, advanced superfluid helium cryostats, electric propulsion, autonomous mobility systems and remote sample acquisition.

Charles Lifer
(818) 354-6580

INFORMATION SYSTEMS DEVELOPMENT AND OPERATIONS DIVISION

The Information Systems Development and Operations Division performs research, development, planning, and operations related to ground-based information systems for spacecraft missions and other tasks in the national interest.

Activities include: (1) mission operations engineering, technology, control, and data management, (2) information systems engineering, technology, and services, (3) ground data systems applications engineering and development, (4) space and institutional networks engineering, and (5) advanced information systems technology development and applications.

Research areas include: (1) advanced automation for spacecraft and ground system operations, (2) machine learning and applications, (3) simulation, modeling, and expert systems, (4) high-rate, high-capacity distributed information systems, (5) software productivity and reliability, (6) high-performance computing and supercomputing, and (7) low-cost mission operations.

Robert Tausworthe
(818) 306-6284

OBSERVATIONAL SYSTEM DIVISION

The Observational Systems Division is responsible for the conception, design, engineering, development, and implementation of a variety of scientific instrumentation for space flight applications. Key elements in the division are digital image processing research and development for space science, environmental and Earth resources applications, and the management and archiving of science data.

T.C. Fraschetti
(818) 354-6677

Imaging and Spectrometry Systems — Technology development and application for advanced imagers, spectrometers and analytical instruments for remote sensing and *in-situ* environments. Provides technology and tools for end-to-end modeling/Simulation of missions and experiments. Develops advanced algorithms and software for scientific data visualization, analysis and modeling calculation, including state-of-the-art work in parallel and network computing. The Section is in the forefront in research and advanced development of instruments for *in-situ* analysis of chemical species including mass spectrometry, scanning electron microscopy, X-ray diffractrometry.

Ray Wall
(818) 354-5016

Microwave, Lidar, and Interferometer Technology — Conceive, design, implement and calibrate scientific optical interferometers, microwave through submillimeter wave passive radiometers, and Lidar observational systems. This includes advanced research and technology development and prototype instrument development to support near term and future remote and *in-situ* space missions. Development opportunities for new instrument systems with the user community.

Gary Parks
(818) 354-8053

Space Instruments Implementation — Conception, design development and implementation of remote and *in-situ* sensing systems to enable both NASA and other agencies space science investigations and observations. Specifically, the lead organization responsible for space flight hardware implementation of observational systems. Performs engineering development, test and calibration for flight instrument systems, including optical imaging and spectrometer systems, microwave and submillimeter radiometer systems, and *in-situ* chemical analysis and electron microscopy instruments for remote and landed science investigations.

Chris Stevens
(818) 354-5545

Science Data Processing Systems
Develops and applies image processing techniques to the display, analysis, and interpretation of image and image-related data. Utilizes engineering and artificial intelligence to develop automated and semi-automated schemes for data interpretation. Performs research and development in image processing. Also develops and applies specialized software, hardware, and systems architectures to increase the speed of computationally intensive functions on large data sets. Provides image processing and analysis support to the flight projects, imaging teams, and the science community.

Bill Green
(818) 354-3031

Science Data Management and Archiving — Design, develop and operate science data systems for producing archive data products from data generated by NASA's observational instruments. Design, develop and operate data catalog and data access systems using DBMS and hypertext based technologies (such as those underlying the World Wide Web). Implement NASA's educational outreach objectives through the development of multimedia-based educational products available on CD-ROMs or on the WEB. Lead in R&D for archive product and distribution technologies such as CD-ROMs and access to massive data archives.

Tom Renfrow
(818) 306-6044

OFFICE OF ENGINEERING AND MISSION ASSURANCE

Microelectronic Radiation Hardness Assurance — Work is focused on research and testing of the reliability of electronic parts in the harsh radiation environments experienced by NASA spacecraft. Current activities include investigations into radiation effects in electronics and photonics caused by heavy ions characteristic of galactic cosmic rays, electrons, protons and ^{60}Co gamma rays; simulation of single event effects (SEE) by ^{252}Cf; and radiation testing of parts for NASA flight projects. In addition, evaluations are performed of test methodologies and process technologies used to produce reliable, radiation-tolerant microelectronic circuits such as application specific integrated circuits (ASICs), field programmable gate arrays (FPGAs) and large memories (SRAMs, DRAMs).

Charles Barnes
(818) 354-4467

Systems Assurance — Systems Assurance conducts research in wide range of areas concerned with the quality and reliability of spacecraft systems. Research opportunities exist in the modeling, analysis, and simulation of the natural and induced spacecraft mission environments and of their effects on spacecraft systems, subsystems, and individual components. Software reliability analyses and metrics definition are other areas of rapidly growing research. Specific issues associated with software, spacecraft sensors, control systems, and other flight hardware are of interest.

A. G. Brejcha
(818) 354-3080

Reliability Engineering — Develops reliability and environmental design, analysis, and test requirements for all JPL flight projects. Reliability activities include electrical and mechanical analyses and environmental requirements activities include: thermal, dynamics, electromagnetic compatibility, and natural space environments. Natural environments include solar and planetary thermal conditions, micrometeoroids and space debris, and space plasma. Induced environments include vibration, acoustic, pyrotechnic shock, and thermal loads, electromagnetic effects, spacecraft charging, etc.

J.F. Clawson
(818) 354-7021

Software Product Assurance — Software Product Assurance has the objective to help ensure the operational integrity of the software developed for JPL systems, and evaluates the operational requirements, the acceptability and readiness of all software prior to delivery. It also researches advanced techniques in software engineering, human computer interface, software safety, and metrics, and performs technology transfer to techniques tailored for the JPL and NASA environment to improve the quality of software within JPL and NASA.

R. Santiago
(818) 354-2452

MULTIMISSION OPERATIONS SYSTEM OFFICE (MOSO)

The Multimission Operations Systems Office integrates the development of hardware and software tools to provide efficient and effective multimission operations systems and services to JPL's planetary science projects in order to minimize the cost of mission operations and data analysis. These systems and services include spacecraft analysis and navigation, mission planning and sequencing, science analysis, mission control and data management, computers and communications, and telemetry.

Terry Linick
(818) 354-3161

HPCC/Earth and Space Sciences (ESS) Project — JPL is interested in research which will lead to new parallel computational methods for distributed memory supercomputing architectures. Areas of particular interest include parallel visualization and analysis of massive data sets, methods for writing portable parallel applications and algorithms, performance optimization, and novel parallel numerical techniques. This work is in support of ESS Grand Challenge science applications, which include multi-disciplinary modeling of Earth and space phenomena, and analysis of data from remote sensing instruments.

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Lyndon B. Johnson Space Center

Houston, TX

The Johnson Space Center is involved in a wide range of activities dealing with human space flight and space exploration. The majority of research areas available for Graduate Student Researchers are in engineering and development and space and life sciences. Additional information concerning the following opportunities may be obtained from the program administrator.

Program Administrator:

Dr. Donn G. Sickorez
University Affairs Officer
Mail Code AP2
NASA
Lyndon B. Johnson Space Center
Houston, TX 77058
(281) 483-4724

ENGINEERING

Advanced Extravehicular (EVA) Systems — The research area includes EVA gloves and advanced thermal protective systems for astronaut space suits, regenerable portable life support subsystems, associated airlock support systems, and equipment that will enhance EVA safety and productivity.

M. N. Rouen
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(713) 483-9242

Life Support Systems Analysis — The research area includes:
l) experimental and theoretical studies leading to greater understanding of biological, chemical, and physical phenomena in air revitalization and water recovery processes; and 2) development of mathematical models for the candidate life support systems for future Moon and Mars missions; and 3) development of automatic control and monitoring techniques at the system level to minimize crew time/effort required for operation of a regenerative life support system.

L. L. Dall-Bauman
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(281) 483-7633

Spacecraft Thermal Management Systems Research — The research area includes: l) light weight, high efficiency heat pumps and unique heat rejection devices to aid in room temperature heat rejection for advanced missions; 2) theoretical studies and analysis techniques for advanced two-phase thermal management systems; and 3) automated monitor, control, and fault detection methods for advanced two-phase thermal management systems.

E. K. Ungar
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Tracking and Communications — Research opportunities exist in optical and RF sensor systems for autonomous landing and hazard avoidance; digital transmitters and receivers; MMIC distributed array antennas; multi-beam and high-gain electronically steerable antennas; high-rate, free-space optical/laser communications systems with ultrahigh convergence and precision acquisition and tracking capabilities; wireless instrumentation systems; space applications of global positioning system capabilities; space-to-ground HDTV; and orbital debris detection and tracking.

William E. Teasdale
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Advanced Life Support Systems
Current research involves development of regenerative human life support systems for future long-duration space missions. Such systems will consist of components which utilize both physicochemical and biological processes to perform the life support functions. Included in these functions are air revitalization, which includes carbon dioxide removal, oxygen generation, and trace gas contaminant control. Water recovery functions include urine treatment, hygiene water processing, and potable water

polishing. Food production functions involve crop production using both hydroponic and solid substrate culturing systems as well as automated/robotic systems for plant production. Resource recovery from solid wastes involves such processes as incineration and pyrolysis, and degradation with bacterial bioreactors. Additionally, integration of these systems into a functioning regenerative life support system via highly automated control and monitoring systems is critical to current development efforts. Research opportunities exist in chemistry, physics, horticulture and plant physiology, soil science, water chemistry, and environmental, chemical, biological, mechanical, computer, and systems engineering disciplines.

D. L. Henninger
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(281) 483-5034

Guidance, Navigation, and Control — Research opportunities exist for definition/development of guidance, navigation, and control systems for space flight programs. These systems include GN&C software algorithms, navigation sensor hardware, flight control sensor and effector hardware. An advanced technical base is maintained involving test and laboratory facilities and computer simulations to analyze, demonstrate, and test new techniques and concepts. Research opportunities also exist in flight dynamics, aerodynamics/aerothermodynamics, and computational fluid dynamics.

Aldo Bordano
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Flight Data Systems — Research opportunities exist for the following areas of interest: High-speed, radiation tolerant avionic systems; micro-electronic hardware components to enable light weight, low-power, ultra-reliable avionic systems for long-duration manned space missions; application of standards to spaceflight data system architectures; fault tolerant standards solutions; real-time object oriented software; application of commercial hardware solutions to space flight environments; radiation characterization analysis hardware; mixed signal ASIC design; fault tolerant backplanes; and distributed processing for sensor signal characterization of impending failures. Laboratory facilities exist to support real-time software and fault tolerant research.

William E. Teasdale
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Propulsion and Power — Propulsion research in the areas of rocket engine combustion and stability, low gravity fluid behavior, high temperature materials, propellant characterization, ceramic applications to small engines and valving, propulsion systems modeling, valving technology, and on-orbit health monitoring. EMA (Electro Mechanical Actuator) research for application to rocket engine gimbaling and aerodynamic surface actuation. ISRU (In-Situ Resource Utilization) research to permit utilization of lunar and planetary resources for propulsion and human life support. Power research in areas of energy conversion systems, including long life and high current density fuel cells and electrolysis systems, nickel-hydrogen and lithium batteries, photovoltaic and solar dynamic power systems, automated management and distribution, and thermal energy storage.

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Power Research
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J**ohn Griffin**
Propulsion Research
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(281) 483-9003

Robotic Simulation — Development of kinematic/dynamic simulations of Shuttle and Space Station telerobots with interactive graphic interfaces is being actively pursued in support of real-time simulation and dynamic analyses. This includes control algorithms for kinematically redundant manipulators, joint servo modeling, control systems interaction, structural contact modeling, and development of simulation architectures. Other areas include multibody dynamic algorithm development (rigid and flexible bodies), friction modeling, and numerical techniques for their solution.

Charles J. Gott
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(281) 483-8107

Computer Graphics Research — Development of advanced graphics techniques for robotic real-time man-in-the-loop simulation development, as well as for video documentation of robotic scenarios. This includes research and development of algorithms such as radiosity and ray tracing, developing efficient graphics front ends to simulations which must run in real time, animation, geometric modeling, virtual reality, and telepresence.

Elizabeth Bains
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(281) 483-1551

Artificial Intelligence — Development of technology to support the design, development and operation of space systems and ground support facilities in the areas of: Real-time Intelligent System Monitoring and control; Failure Detection and Diagnosis; Intelligent System Modeling and Analysis; Automated Design Knowledge Capture; Automated Planning and Scheduling; Fault Tolerant Robotic Control and Adaptive Control of Multi-modal High Degree-of-freedom; and Nonlinear Systems. Technologies under development for these functional areas include: Intelligent Computer-Aided Concurrent Engineering; Discrete Event Simulation and Qualitative Modeling; Advanced Human-Machine Interaction Design Methodologies, Object-Oriented Programming Methodologies; Knowledge Representation for Sharable Engineering Knowledge Bases; Intelligent Pattern Recognition and Trend Monitoring; Real-time Expert Systems; Advanced Search and Optimization (including Evolutionary Computation, Genetic Algorithms/Genetic Programming, Massively Parallel and Distributed Processing Implementation); Adaptive and Intelligent Control (including Machine Learning, Neural Networks, Fuzzy Logic); Advanced Text Processing and Semantic Classification; Automated Knowledge Acquisition and Data Mining; and Distributed Optimized Planning and Scheduling.

Jon D. Erickson
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Robotic Applications — Development of emerging technologies, such as advanced control schemes (i.e., force/torque feedback and adaptive control), dexterous hands/arms, multi-arm control (for both kinematically sufficient and redundant systems), external sensing, collision detection and avoidance, on-line path planning, remote control of multiple robots at diverse locations, and application of these technologies to mobile platforms and fixed hand manipulators.

Edith C. Taylor
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Intelligent Robotics — Development of computer software architectures to support human-supervised intelligent robotic systems for human/robot teams in space and development of component technologies such as reasoning, planning, perception, sensing and actuation. Current research is focused on approaches to combining reactive and deliberative planning paradigms to produce robust control schemes for agents operating in dynamic environments.

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SPACE & LIFE SCIENCES

Biomedical and Nutrition Research — The present program seeks to define the cellular, biochemical, and physiological changes that are related to the integrated physiological response to space flight, with the goals of defining and monitoring crew health and developing countermeasures. Flight-induced changes in fluid and electrolyte balance, orthostatic and cardiovascular function, erythropoiesis, and the musculoskeletal, immunological, and metabolic nutrition systems are being investigated during space flight and using ground based moedles such as head-down bed rest, and in vitro using cell
cultures.

Scott Smith
smsmith@SDPCMAIL.jsc.nasa.gov

Endocrine Biochemistry — Ongoing projects include in vitro and in vivo studies of space flight-related perturbations to calcium, carbohydrate, and protein metabolism, sodium homeostasis, and the reninaldosterone response. Analytical methods are being developed for identifying hormone-binding proteins, antidiuretic hormone, atrial natriuretic hormone, and parathormone. Other methods are being developed to assess electrolytic and hormonal status noninvasively during simulated and actual space flight.

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Immune Responses to Space Flight — The purported detrimental effect of space flight on the immune system has far-reaching implications for maintaining crew health in space, particularly on long missions. Ongoing projects include characterization of receptors on peripheral-blood monocytes by flow cytometry and image analysis; analysis of the antibody response to microbial challenges in vitro; and characterizing changes in microbial physiology as they relate to the risk of infectious disease.

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Cell Science and Immunology — Ongoing projects include the investigation of space flight effects on human immune function and basic cellular responses to microgravity. These studies include the assessment of cell activation, cell-cell interaction and signal transduction in microgravity culture; investigation of immunoregulatory factors (cytokines; prostaglandins) and immune cell function during/after space flight; and the determination of humoral immune responses during space flight.

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Biotechnology and Bioprocessing Microgravity can be used to facilitate the separation and synthesis of medically important biological materials, as well as to enhance the formation of tissue-like aggregates in specially designed bioreactors. Theoretical and experimental projects are under way to improve cell-culture techniques using normal and neoplastic cell types under microgravity conditions.

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Pharmacokinetic Research — Space flight appears to alter the disposition of drugs administered to crew members. Characterizing these changes is essential to design effective treatments for illnesses in flight. Bed-rest and in-flight studies are being conducted to identify the physiological changes that influence drug disposition; to develop simple, noninvasive monitoring procedures that can be used in microgravity; to develop computer models of pharmacokinetics; and to develop appropriate drug-delivery systems.

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Environmental Physiology/ Biophysics Research — The physiological and biophysical interactions of environmental factors such as gas species and their partial pressures, temperature, gravity, decompression and barophysiology, and exercise are being investigated by the Environmental Physiology Laboratory. Experiments involving human subjects, primarily in the are of hypobaric barophysiology, and mathematical models of decompression are currently being pursued. The goal is the understanding of physiological problems to reduce the time impact of countermeasures (e.g., oxygen prebreathe) and developing monitoring equipment.

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Psychological Research — The Psychology and Behavior Laboratory conducts investigations to develop effective crew selection, training, and in-flight support procedures and guidelines for manned space missions. Toward this end, specific areas of study include stress and adaptation to extended confinement, team dynamics and leadership, team composition, methods of nonintrusive measurement, cognition, and performance assessment.

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Neuro-Physiology — Investigations in the Neuroscience Laboratory are designed to understand the physiological mechanisms involved neurosensory, perceptual, and sensorimotor adaptation to space flight and readaptation to Earth. Included are investigations of eye-head, eye-hand, eye-head-hand coordination, vestibulo-spinal reflexes, posture and gait control processes, perception and spatial orientation processes, and space motion sickness. A major focus of the work in this laboratory is to develop effective countermeasures for the neurosensory disturbances, and motion sickness that occur in-flight and upon return to Earth.

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Exercise Physiology — The Exercise Physiology Laboratory is intimately involved in investigations which support the Space Biomedical Research Institute. The investigators and engineers are also active in the development of future flight hardware for extended space flight. A major aim is to understand the degradations in exercise capacity and the role which exercise may play in the maintenance of normal function in other physiologic systems.

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Cardiovascular Research — The cardiovascular laboratory studies mechanisms of changes to the cardiovascular system as a result of space flight. The primary areas of research include study of changes in cardiac rhythms in-flight, including during extravehicular activities, and changes in autonomic control of blood pressure during and after flight.

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Space Food Development — The Food Systems Engineering Facility supports food development activities for the Shuttle, Space Station, and future missions. Weight and volume of space food systems are critical and projects like Lunar Base and Mars missions require major efforts in food development. Research areas of interest include: food development, acceptability measures for microgravity and isolation, food bioregeneration, shelf life, preservation, packaging, and food waste management.

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Space Radiation — Research in space radiation with the emphasis on the need for crew health protection. The experimental program involves passive dosimetry measurements with thermoluminescent detectors and active dosimetry measurements, which involve development of new charged particle detectors that are flown on the Shuttle. The theoretical program includes the study of and improvements in the trapped radiation belts models, the galactic cosmic radiation models, and studies related to solar energetic particle events.

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Orbital Debris — The objective of this theoretical and experimental program is to improve the definition the near-Earth artificial satellite population with an emphasis on understanding the causes and effects of satellite breakups as well as other sources of orbital debris. Models are developed which combine sources with natural sinks to describe the evolutionary satellite environment for both low and high Earth orbits. Measurements of debris physical properties and flux are performed using optical, infrared, and radar sensors and the examination of impacted surfaces from returned spacecraft or photographs of on-orbit satellites. Hypervelocity guns are used to test spacecraft shielding concepts.

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Planetary Materials Analysis — Research involves laboratory analysis of lunar rocks, terrestrial rocks, meteorites, and cosmic dust particles to unravel the early geochemical history of solid matter in the solar system, the geologic evolution of planets and rocky protoplanetary objects, including comets, to plan the technology for a lunar base, and for robotic missions to the moon, Mars, and asteroids. Remotely sensed data of Earth and other planetary bodies are also used for these same objectives.

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Earth Observations Database — The NASA Space Shuttle Earth Observations Database is a valuable source of data for research of Earth=D5s recent environmental history, and thus for assessment of the human impact on global Earth processes. This data source, although having the longest length-of-record of any space-derived global change database, has not been fully exploited by scientists studying the global changes. With the inception of NASA=D5s =D2Mission to Planet Earth=D3 program there is a need to integrate these important data into global change studies. Global land processes such as land use, deforestation, soil and land degradation, erosion, desertification, soil salinization, long-range dust transport, hydrologic changes, and stream and reservoir sedimentation have been extensively documented during the 100 Space Shuttle missions flown during the last fourteen years, as well as by similar baseline data acquired during the even earlier NASA manned space flights extending to 1961. These observations provide researchers a unique perspective on our planetary habitat and add understanding and critically important early data points to our models of land use dynamics and their ecological implications.

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Human Factors/Research on Human-Computer Interface (HCI) — For upgrade of current vehicle HCI and the planning of new vehicles and ground support HCI, research is required. Topics of interest would cover a variety of Human-Computer Interface (HCI) designs, prototypes and evaluations for NASA shuttle, space station, future vehicles and ground-based operations. Additionally, research would be performed on interface design issues and the development of display standards and guidelines. Evaluations of HCI can be conducted in the Human Factors laboratory at JSC, on the KC-135 aircraft and onboard the shuttle. Topics would include: Task Analysis; HCI design; Prototyping (SuperCard and/or Toolbook and/or SAMMI); HCI research; mental workload; and Usability testing.

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Human Factors/Research on Advanced Input Devices — A large number of portable and special purpose microcomputers fly on the shuttle during each mission in support of mission objectives and payload experiments. Some human factors research has been completed to evaluate cursor control devices for use with these computers. Evaluations have included mice, trackballs, mousepens, and thumb–balls. Given recent advances in input technologies (high resolution touchscreens, voice input systems, etc.) it is desirable to evaluate some new devices for microgravity use. A few touch–screens have already been used in microgravity, but no formal evaluation of the technology has been completed.

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Computational Models for Human Factors — Use of computational models of humans and their environments has greatly enhanced and expanded the levels of predictability of performance. This approach is especially effective when it is able to integrate multiple and diverse components for specific and comprehensive solutions. Major areas of research include computer aided design , anthropometric representations, kinematics, light and vision, sound and hearing, strength, speech, task analysis and cognitive behavior. Computational representations of these areas need to be further researched, developed and validated. Key words include, computer modeling, computer aided design, path-planning, ray-tracing, radiosity, inverse kinematics, and virtual environments.

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SAFETY, RELIABILITY, AND QUALITY ASSURANCE

Risk Management — Opportunities exist for research in areas related to reliability and safety of space vehicles. Multivariate models, such as logistic regression and proportional hazards models, and system reliability models that make use of dependencies between component failure events are specific topics of interest in statistical reliability. Probabilistic fatigue and other physics-of-failure modeling which may include simulation studies using finite element models are safety topics of interest.

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INFORMATION SYSTEMS

Advanced Training Technologies
Proposals are sought that advance the state-of-the-art in technologies that support training of NASA astronauts and ground-based personnel, including simulations. NASA has a special interest in technologies that will reduce the cost and/or enhance the effectiveness of training and training development. Proposals are strongly encouraged that demonstrate a high probability of dual-use in industry and/or education for the developed technologies.

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John F. Kennedy Space Center

Kennedy Space Center, FL

The John F. Kennedy Space Center (KSC), located near Cape Canaveral, Florida, is NASA's primary launch site. The Center handles the preparation, integration, checkout, and launch of space vehicles and their payloads. Areas of research available for Graduate Student Researchers are listed below. Additional information concerning the following opportunities may be obtained from the university programs manager. Applicants are strongly advised to contact the KSC Program Administrator prior to submitting an application.

Program Administrator:

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University Programs Manager
Mail Stop: HM-CIC
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ENGINEERING DEVELOPMENT

Instrumentation Division — Develop, design, and test a variety of state-of-the-art instrumentation sensors and systems to support Space Shuttle, Payloads, and Space Station checkout and launch including innovative sensors to detect cryogenic and hypergolic propellant leaks and fires, protect payloads from contamination, guide the mating and assembly of the Orbiter, External Tank, Solid Rocket Boosters as well as Payloads, automatically assess the integrity and flight worthiness of vital flight systems such as the Orbiter windows, reinforced carbon-carbon wing leading edges, Orbiter body flap and rudder/speed brake, etc., as well as sytems to guide the Space Shuttle to safe landings at primary and contingency landing sites world-wide.

Communications Division — Expert in digital radio systems is needed to study the advantages and disadvantages of Spread Spectrum communications methods, for use with voice and data transmission communications systems. Both frequency hopping and direct sequence are to be addressed. Evaluation of Gold, Linear Maximal and Non Linear, and Error Detection and Correction (EDAC) Codes are to bd addressed for various applications, and trade-off analyses performed.

Various Digital Modulation techniques for use with future Spread Spectrum communications systems are to be studied. The study should also consider a trade-off between circuit complexity and use of fewer, more expensive components.

Communications/Fiber Optics — Continued work with multi and single mode optical fibers exists as well as development activities in optical multiplexing, switching, repeaters, and various fiber optic instrumentation techniques. Applications for research also include high speed baseband and broadband communications in the integrated networking environment and high reliability/redundant dedicated circuits.

Communications/Networks — Research, development, and evaluation of leading edge network architectures, network operating systems, and network protocols. These would be for local area networks (LAN), metropolitan area networks (MAN), wide area networks (WAN) and the internet. Focus study or analysis would include reduction of implementation and operating costs of existing systems, system expansions, and new systems. This is to be accomplished through the application of new technology, new techniques and consolidation of systems.

Advanced Systems and Analysis Division — The advanced systems and analysis division performs a variety of analyses for existing and future launch systems and develop and applies advanced software, automation and robotics technology for improving the efficiency and safety of ground operations at Kennedy Space Center. Technology development and application efforts are focused on solving specific problems with existing operational processes and future launch vehicle processing. A variety of analysis tasks are performed within the division. The tasks are both theoretical and experimental. Theoretical analyses include: acoutics, dynamics, thermal and heat transfer of cryogenic systems, structural (i.e., stress, deflection, vibration), fracture mechanics, flow induced vibration, and single and two-phase flow. Experimental analyses, vibration troubleshooting and diagnosis.

Research opportunities in the area of advanced software include development of knowledge based systems for: real time monitoring and control of complex checkout and launch procedures, imbedded diagnostics, fault isolation, planning and scheduling management. Additional opportunities include: human computer interfaces and application of virtual reality techniques to system control.

Research opportunities in the area of automation and robotics include development and application of existing and new robotics and automation technologies in time critical, hazardous, and labor intensive tasks. Technologies of interest include: machine vision, teleoperation, precise positioning, force-torque control, remote sensig, intelligent tools, imbedded control. Applications currently being investigated include a variety of inspection tasks (e.g., Orbiter tiles, HEPA filters, wire rope, piping) and hazardous tasks (e.g., hazmat, rewaterproofing of Orbiter tiles, security operations).

BIOLOGICAL PROGRAMS

CELSS Research — Breadboard Project includes crop growth and production, chemical allelopathy, microbial ecology, biomass conversion, and systems control and automation. May conduct short-term environmental response test for community gas exchange and nutrient uptake. Learn to track gaseous and microbiological contaminants in a CELSS system. Biomass conversion research in extraction of water-soluable compounds from crop residue, enzymatic hydrolysis of crop residue cellulose, production of edible mycoprotein, conversion of organic particulates and soluable residues from all other reactors into microbial biomass, and aquaculture research. Robotic techniques for planting, culturing, and harvesting crops in a closed growth chamber.

Environmental/Ecological Research — Research on effects on Kennedy Space Center operations on barrier island ecosystems. Studies also include monitoring and assessment of habitat management programs on vegetation, Federally-listed threatened and endangered species, and other protected species found on Kennedy Space Center's wildlife refuge, including Florida scrub jay, bald eagle, gopher, tortoise, mantee, indigo snake, Florida beach mouse, and several species of sea turtle. Studies on use of geographic information systems (GIS) as decision support for environmental monitoring and management.

SPACE BIOLOGY

Plant Space Biology Research — Research on carbon exchange rates and carbohydrate metabolism of higher plants in response to gravity. Includes studies of plant growth with lighting systems proposed for space-flight, such as high-output LEDs, effects of closed atmospheres and ethylene on plants, and development and testing of nutrient delivery and rooting systems for growing plants in microgravity. Studies on changes in gene expression in response to different factors of the spaceflight environment.

PAYLOADS DIRECTORATE

Flight Hardware Engineering — Activities involved in the development and verification testing of space flight hardware in support of life sciences research in space. The challenge is to provide an appropriate environment within the mass, size and power constraints of a Space Shuttle middeck locker. This involves hardware development utilization expertise in mechanical, electrical, electronics and computer hardware and software engineering. Other research tasks involve ground-based and flight verification of the appropriateness of the hardware as a research tool.

ATMOSPHERIC SCIENCES

Lightning Threat Detection — Development of techniques for remote in situ detection and measurement of electric charge and electric fields in and around clouds. Application of traditional or Artificial Intelligence methods to integrating data from radar, surface electric field mills, and several electromagnetic lightning location systems into a single, simple presentation of the magnitude and spatial distribution of the threat of natural lightning and lightning triggered by launch vehicles.

Short-term Local Weather Prediction — Improvement of the capability of mesoscale numerical weather prediction models and other tools for the detailed forecasting of weather specific sites such as the Space Shuttle Landing Facility for forecast lead times from 30 minutes to several hours. Development of methods to maximize the utility of the dense local network of meteorological sensors at Kennedy Space Center and Caper Canaveral Air Station for making short-term site-specific operational forecasts.

SAFETY, RELIABILITY AND QUALITY ASSURANCE

Systems Safety — Perform research in the identification and control of hazards, probabilistic risk assessment, fault tree analysis and applications, interactive hazard information tracking and closure systems, reliability engineering.

Quality Engineering — Perform research in the application of statistical process control, methods and analysis, automated assessment techniques and evaluation of inspection methods.

SPACE SHUTTLE PROCESSING

Industrial Engineering — The development of industrial engineering tools for supporting efforts to improve Shuttle processing efficiency and effectiveness. Specific areas of interest include: schedule and cost risk analysis, process simulation, work measurements, human factors, engineering, and benchmarking.

Launch Processing System — The new Launch Processing System project has need to support development and research associated with modern high speed networks. Specific assignments would be made in the area of developing a prototype network between computers using modern networking techniques such as: reflective memory, asynchronous transfer mode technology, FDDI networks or 100Mb Ethernet. The prototype network would then be benchmarked to examine performance characteristics for trade studies and use in the new LPS Minimum System.

KSC Safety and Shuttle Upgrades Modifications — KSC is reviewing various technologies to upgrade and modify the shuttle fleet. Areas of interest include: electro-mechanical actuators technology, advanced avionics systems, neural networks, automated vehicle health management, and oxygen/ethanol propulsion systems.

Langley Research Center

Hampton, VA

The mission of the NASA Langley Research Center is to increase the knowledge and capability of the United States in a full range of aeronautics disciplines and in selected space disciplines. The following information provides, by Group, an overview of the current disciplines in the Langley program. Specific research activities associated with each discipline are also included.

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RESEARCH AND TECHNOLOGY GROUP

The Research and Technology Group consists of approximately 800 scientists, engineers, technicians and support personnel who are responsible for performing basic research and technology development in a broad range of aeronautical and selected space disciplines. Through an interdisciplinary approach, the Group produces proven and usable technology for aerospace and non-aerospace customers. The Research and Technology Group program include the following types of research activities:

Aerodynamics — Opportunities for research in the aerodynamics area include subsonic aerodynamics, transonic aerodynamics, supersonic aerodynamics, full-scale Reynolds number technology, propulsion integration, takeoff and landing characteristics, applied CFD, wind-tunnel operations, productivity improvements, and advanced test techniques.

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Propulsion Integration

Flight Dynamics and Controls — Opportunities to conduct theoretical and applied research in flight dynamics include hazard characterization, detection and avoidance, laminar flow control, high Reynolds number research, and configuration aerodynamics. In the area of controls and guidance, for both aircraft and spacecraft, opportunities exist in multidisciplinary, nonlinear system analysis, design, and implementation, as well as crew station technology. Human factors issues are addressed through research in flight management and vehicle operations technology, advanced human and automation integration, improved cockpit/crew interfaces and decision aids. Research being performed in these areas is targeted for aircraft operating in all speed regimes, as well as to launch systems and orbiting spacecraft.

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Langley Research Center

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Crew Systems & Operations

Fluid Mechanics and Acoustics — Opportunities are available in the areas of computational, theoretical and experimental fluid mechanics and acoustics. Fluid mechanics research addresses: the enhanced understanding of viscous flow phenomena including boundary layer transition, turbulence, and separated and vortical flows; modeling of transition, turbulence, and vortical flow phenomena; computational fluid mechanics including accurate and efficient algorithm development; innovative flow control concepts for reducing induced and friction drag, enhancing performance of future high-lift systems, and reducing/increasing mixing; advanced non-intrusive flow diagnostics, and computational multi-disciplinary design optimization systems. Acoustics research addresses the understanding, prediction, and reduction of the noise associated with subsonic and supersonic aircraft. This computational, theoretical and experimental research focuses on engine, rotor, and airframe noise as well as sonic booms generated by supersonic aircraft. Specific areas include: tilt-rotor/helicopter noise, fan and jet noise, propeller noise, laminar flow acoustics, acoustic response, interior noise, sonic fatigue, structural acoustics and noise propagation. The area of computational acoustics represents a major new research thrust.

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Gas Dynamics — Opportunities for research in both focused and basic research and technology development in the areas of aerothermodynamics and hypersonic airbreathing propulsion. Develop, validate, and perform analytical, computational and experimental aerodynamic, aerothermodynamic and fluid physics research to develop, optimize, and evaluate future experimental flight demonstration vehicles and aerospace vehicles. Develop, validate, and perform multidisciplinary research to develop advanced technology for hypersonic airbreathing propulsion systems for aerospace vehicles. The focus is on airframe-integrated engine concepts having high performance over a wide range of flight Mach numbers.

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Gas Dynamics

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Aerodynamics

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Propulsion

Flight Electronics Technology Division — Opportunities for research exist covering flight electronic system sensing, computing, and display for aerospace applications. Flight system sensing includes laser sensing, microwave remote sensing technology including electromagnetic analysis methods, far-field and near-field antenna measurements, compact range technology, and aircraft and spacecraft antenna technology. Computer technology and data processing research areas include optical data processing, solid-state memory technology, very-high-speed information processing, concurrent processing, and highly reliable and fault-tolerant systems.

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Systems Integration

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Assessment Technology

Materials — The Materials Division conducts research on advanced materials and nondestructive evaluation (NDE) technologies for aircraft and spacecraft structures. Materials research includes development of high-performance polymers, light alloys and composites, and the processing and manufacturing technologies required to improve performance and reduce weight and cost of aerospace structures. Service life testing is performed to establish durability of these materials under simulated aircraft and spacecraft service conditions. Analyses and modeling are performed to predict structural integrity and develop a fundamental understanding of failure mechanisms. Nondestructive evaluation techniques and methodologies are developed to inspect aircraft and space launch vehicle structures.

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High-Performance Polymers and Polymer Matrix Composites

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Nondestructive Evaluation Sciences

Structures — The Structures Division conducts a wide variety of analytical and experimental research aimed towards the development of more efficient structures for aircraft and space vehicles. Research studies focusing on analytical methods for improving structural analysis and design are developed and validated by laboratory experiments. New structural concepts for both metal and composite structures are also developed and evaluated through laboratory testing. Additional research is conducted in integrating advanced structural and active-control concepts to enhance structural performance. Studies of landing and impact dynamics focus on increasing safety during ground operations and crash impact. Research in the aeroelasticity area ranges from unsteady aerodynamics for current and future aircraft and space vehicles to wind tunnel tests of flutter models. The division operates a number of major facilities. These include the Langley Aircraft Landing Dynamics Facility, the Langley Impact Dynamics Research Facility, the Dynamics Testing and Research Laboratory, the Langley Transonic Dynamics Tunnel, and the Langley Structures and Materials Research Laboratory.

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Design for Competitive Advantage — A major problem facing the aerospace industry is how to become more competitive. Decreased cost and increased quality characterize the increased value necessary to improve competitive advantage. This task is to concurrently examine, in the context of competitive advantage, (1) an aerospace product and (2) the system by which we bring forth, sustain, and retire that aerospace product.

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Information and Electromagnetic Technology — Opportunities for research covering information acquisition, information processing and information display for aerospace applications. Information acquisition includes laser sensing, microwave remote sensing technology including electromagnetic analysis methods, far-field and near-field antenna measurements, compact range technology, and aircraft and spacecraft antenna technology. Information processing and computer technology research areas include optical data processing, solid-state memory technology, very high-speed information processing, concurrent processing and highly reliable and fault-tolerant systems.

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AIRFRAME SYSTEMS PROGRAM OFFICE

The Airframe Systems Program Office (ASPO) is responsible for planning, advocating, and coordinating the Agency's Airframe Systems Research and Technology (R&T) Base Program. Its responsibilities include developing a strategic plan for a range of research programs that blend efforts of NASA Centers, industry, universities, other Government agencies, and other research laboratories. These efforts are aimed at meeting the national goals in aeronautics. ASPO provides program management to ensure that its research supports national needs, that research goals are met in a timely manner, and that resources are used efficiently. Working with the Technology Applications Group and research organizations, ASPO managers ensure timely transfer of technology to internal and external customers.

Within ASPO, the Aeronautics Systems Analysis Division (ASAD) conducts mission and vehicle concept studies to establish the basis for potential new aeronautics research activities. ASAD develops methodologies for integrating discipline technology into efficient vehicle and systems concepts. Suboffice leaders interact with external customers and NASA research organizations to determine requirements for future vehicles and specific programs required to accomplish objectives.

Aeronautics Systems Analysis Division — ASAD's Systems Analysis Branch conducts multidisciplinary studies and analyses of advanced vehicles and the integrated air traffic system.

Disciplinary expertise within the branch for conceptual studies includes the following areas:

•Aerodynamics/stability and control
•Propulsion and noise
•Performance and sizing
•Configuration integration and subsystems
•Weights/structures and aeroelastic analysis
•Costs/risks/airspace system and global benefits

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Subsonic

INTERNAL OPERATIONS GROUP

The Internal Operations Group (IOG) supports the Center's research programs and project activities, with special emphasis on formulating and implementing major policies and programs relating to resources management, acquisition and contracting activities, data systems management, and technical support services. This support also includes the Center's Construction and Facilities program; all functions necessary to design, install, operate, and maintain large mechanical and electrical systems, complex research facilities, and equipment and test apparatus; all functions necessary to provide and maintain institutional buildings, structures, and grounds; all functions necessary to provide design, analysis, fabrication, and operation of complex aerospace systems and research test articles; Center-wide electronic discipline for projects and programs; the operation and maintenance of the Center's central computer complex and simulation facilities; and all functions necessary to operate and maintain the Center's daily flight operations inclusive of aircraft and avionics maintenance, research pilot staff management, and direction of all related design, fabrication, testing, and certification of experimental flight control and display systems.

Electronic Aerospace Systems Division — This organization pioneers and provides technology, systems, and services in the areas of instrumentation, scientific computing, and simulation to sustain Langley's continued research preeminence. The following items represent active research disciplines.

Advanced Sensor Systems — This activity develops solid-state laser lidar systems, semiconductor detector, and high-temperature superconductor technologies for spaceflight applications.

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Solid-State Laser Technology

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Semiconductor Detector Technology

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Solid-State Laser Materials

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UV & IR Detector Technology Measurement Science and Instrument Technology — This activity develops far-infrared sensor tech-technology, electromechanical sensors, digital data systems, optical and laser spectroscopy, mass spectrometry and gas chromatography, pressure measurements, thermal measurements, structural dynamics and acoustics measurements, optical interferometry and photogrammetry techniques, and electronics applications.

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Far-Infrared Sensor Technology

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Electromechanical Sensors
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Digital Data Acquisition

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Aeroelastic Deformation Measurement

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In Situ (Aircraft-Based) Sensors

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Microelectronics and Microprocessors

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Aerodynamic Force/Moment Measurements

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Advanced Instrument Pointing and Tracking and Scanning Systems

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Analog Digital Processing

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Aircraft Data Systems

Materials Characterization Technology — This activity includes nondestructive evaluation electromagnetics, ultrasonic propagation and scattering in composites, ultrasonic arrays, signal processing, image analysis, nonlinear acoustics, electron microscopy, microstructural physics, elastic behavior, X-ray tomography, fiber optic sensors, and electronics reliability.

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Microstructure of Polymers

Advanced Computational Capability — This activity includes piloted simulation, computer-generated scientific visualization, image processing, grid generation, numerical techniques for high-performance scientific computers, computer networking technology, user interface development, and mass storage techniques.

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Piloted Simulation

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Scientific Visualization
Numerical Techniques for High-Performance Scientific Computers

Langley Research Center

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Data Management
User Interface Development

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Computer Network Technology

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Mass Storage Techniques
Scalable Computing Architectures
World Wide Web (WWW) Technology

Automated Information Security
This activity develops risk analysis methodology for a distributed systems environment, computer security applications, and system interrogation techniques.

Mike Little
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Automated Information Security

Management Information Systems — This organization handles Business, Administrative, and Management Information Systems development, integration, and operation; technology assessments and assimilation; business process and data modeling; application of expert systems, distributed relational database management systems, image processing systems, and decision support systems; mainframe, client/server, and personal computing platforms.

Fred Moore
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Engineering — This activity provides the engineering design and fabrication of flight hardware and research test articles and equipment; the planning and implementation of the Construction of Facilities program and all institutional services in support of the aeronautical and space research programs of the Langley Research Center.

Mechanical Systems Engineering
This activity includes the design, analysis, development, and testing of research systems. These systems include spaceborne and aircraft experiments and instruments required to conduct the LaRC research and technology program.

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Mechanical Systems for Space Remote Sensing Instruments and Technology

Dr. William S. Lassiter
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Systems Level Thermal, Fluids, and Structural Analysis and Verification

Facility Systems Engineering —
This activity engineers, designs, constructs, and activates aerospace research facilities and equipment for aeronautical and associated institutional facilities for aeronautical and space research. Typical products include low and high speed wind-tunnel facilities and equipment, including tunnel pressure shells and support systems, tunnel internals, automated control systems, devices to facilitate test measurements, process systems, model handling equipment and calibration systems. Other typical products include test cells, simulation equipment, environmental test chambers, clean rooms, laboratories with ancillary systems and equipment, robotics systems, and other specialized research test apparatus/equipment.

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Structural Finite-Element Modeling, Dynamic Structural Analysis

Engineering Lab Team —
Physical and chemical analytical testing services are needed for the operation of facilities at LaRC. Analytical instrumentation is developed that will advance services at LaRC or will advance technology in aeronautics and space projects such as instrumentation for environmental controls, X-ray fluorescence spectroscopy for wear metal, agricultural and geological analysis, flow field and temperature visualization for wind tunnel models, and high temperature superconductive materials magnetic levitation.

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Fabrication Division —
This office provides support in mechanical, electronics, and materials technology for the Center's engineering and research organizations during the development, fabrication, and testing of

research models, flight and related ground support hardware, facility components, and laboratory test apparatus. The office administers contracts of major scope for services and tasks relative to the Center's research manufacturing requirements. The office establishes/ implements manufacturing standards and quality assurance procedures in accordance with LaRC's Safety, Reliability, and Quality Assurance Program. The office determines requirements and initiates procurement of advanced manufacturing equipment and directs the development of fabrication processes applicable to unique materials and applications. The office also formulates, establishes, and maintains direct charge system for fabrication support.

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Hypersonic Vehicles Office — The Hypersonic Vehicles Office is the Agency lead for hypersonic research and for the development of hypersonic technologies in all disciplines. Results from these activities will have application for both aircraft that cruise within the atmosphere and for launch vehicles that leave the atmosphere. The current major focus for the office is the Hyper-X Program that is an effort to develop and flight test a sub-scale hypersonic airplane configuration which will provide the first demonstration of an airframe-integrated scramjet engine at Mach numbers of 5, 7, and 10.

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SPACE AND ATMOSPHERIC SCIENCES PROGRAM GROUP

The goal of the Space and Atmospheric Sciences Program Group is to conduct research that will establish and maintain a solid foundation of technology embracing all of the disciplines associated with space and atmospheric sciences; and to provide a wellspring of ideas for advanced concepts. These programs include the following disciplines and specific research activities:

Stratospheric Aerosol and Gas Experiment (SAGE) — Analysis and interpretation of atmospheric aerosol, ozone, nitrogen dioxide, and water vapor measured from SAGE I (1979-81) and SAGE II (1984-present) satellite instruments. Studies are directed toward developing global climatologies of these species and understanding the role these species play in atmospheric processes such as ozone depletion and global warming.

Lamont R. Poole
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Climate Research Program
Theoretical, laboratory, and field investigations of the radiative properties of natural volcanic and man-made aerosols and assessment of their impact on regional and global climate. Remote and in-situ observations of cloud properties and radiation balance components and theoretical studies of the role played by clouds in the Earth's radiation balance.

Patrick Minnis
(757) 864-5671

Tropospheric Chemistry Research Program —
Assess and understand human impact on the regional-to-global-scale troposphere; define chemical and physical processes governing the global geochemical cycles from empirical and analytical modeling studies, laboratory measurements, technology developments, and field measurements; and exploit unique and critical roles that space observations can provide.

James M. Hoell
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Upper Atmosphere Research —
Expand the scientific understanding of the Earth's stratosphere and the ability to assess potential threats to the upper atmosphere. Includes developing empirical and theoretical models, formulating new instruments and techniques, performing laboratory and field measurements, and performing data analysis and interpretation studies.

William L. Grose
(757) 864-5820

Earth Radiation Budget Experiment (ERBE) — Analysis of measurements from instruments on three satellites that provide data on the Earth's radiation budget for assessing climatic impact of human activities and natural phenomena as well as a better understanding of all climatic parameters, in particular, the radiation budget components on a global scale.

Bruce R. Barkstrom
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Langley Research Center

Halogen Occultation Experiment (HALOE) — Analysis and interpretation of measurements from this experiment on the Upper Atmosphere Research Satellite to improve understanding of stratospheric ozone depletion, particularly the impact of chlorofluoromethanes on ozone by analyzing global vertical profile data of O3, HCl, CH4, H2O, NO, NO2, and HF.

John G. Wells
(757) 864-1859

Global Biogeochemical Cycling — Theoretical and field investigations of the biogeochemical cycling of atmospheric gases, with particular emphasis on the global budgets of oxygen, nitrogen, and carbon dioxide to better understand global change. Field measurements include studies of biogenic emissions of atmospheric gases from the soil and oceans and gases produced and released to the atmosphere during biomass burning, i.e., the burning of the world's forests and grasslands.

Joel S. Levine
(757) 864-5692

Transportation Systems — Future space vehicle concept development, operations, research, and computer-aided design.

Charles H. Eldred
(757) 864-8211

Spacecraft System Studies — Spacecraft concept development studies for Global Change science missions; large Earth orbiting spacecraft and platform systems studies; spacecraft subsystem analyses, performance, and technology assessments; mission design; and computer-aided design and simulations.

Richard A. Russell
(757) 864-1935

TECHNOLOGY APPLICATIONS GROUP

The commercial technology mission of NASA requires that each NASA program be carried out in a way that productively involves the private sector from the onset, through a new way of doing business, to ensure that the technology developed will have maximum commercial potential. At Langley, the Technology Applications Group (TAG) is responsible for introducing, facilitating, promoting, and supporting technology transfer and commercialization of advanced aeronautics, space and related technologies.

Technology Transfer/ Commercialization — Transfer of LaRC-developed technologies is to American companies/industries, with emphasis on non-aerospace applications, but team members will also help researchers transfer technologies that only have aerospace applications.

Lance B. Bush
(757) 864-4514

Communication Technology — Dissemination tools for promoting the expedient transfer of technologies over Internet (World Wide Web) and commercial object-oriented electronic distribution models and methodologies.

Stuart E. Pendleton
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Lewis Research Center

Cleveland, OH

The Lewis Research Center has a broad research program embracing aeronautical propulsion, space propulsion and power, space electronics, and microgravity science. Brief descriptions of some of the major research activities at Lewis follow.

Program Administrator:

Dr. Francis J. Montegani
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Lewis Research Center
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AEROPROPULSION ANALYSIS

Aircraft Propulsion Systems Analysis — Advanced propulsion concepts are conceived and analyzed to estimate performance for typical flight vehicle applications, determine relative merits compared with alternative propulsion systems, and derive optimum designs of systems integrated with a vehicle. Also, analytical and numerical models that predict performance, noise, and weight of complete propulsion systems and components are developed, along with models of flight vehicles.

Brijendra Singh
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INSTRUMENTATION AND CONTROLS TECHNOLOGY

Controls and Dynamics — Advanced digital electronic and fiber-based controls and systems are developed for air breathing and rocket engines, motivated by increased performance, operability, and durability requirements. Included in the scope of the research are control theory applications, real-time flight/propulsion simulation, integrated flight/propulsion controls, system life-extending controls, fiber-optic and electro-optic control components, and robust fault-tolerant controls and systems. Application of neural networks to controls and advanced dynamic modeling and modeling methodologies are active research areas also.

Walter C. Merrill
(216) 433-6328

Optical Measurement Systems — Optical instrumentation technology is developed for aerospace propulsion R&D requirements, for propulsion system control, and for space experiments. This technology includes optical and fiber-optic sensors and laser-based techniques for nonintrusive gas path diagnostics and structures measurements. New systems for both point and whole-field measurements of parameters such as velocity, temperature, and species concentration are conceived and developed in the Division's laboratories and also demonstrated in Center research facilities.

Mark P. Wernet
(216) 433-3752

Sensors — Research sensors are being developed to support a wide variety of applications which include materials development, structural testing, aero-thermal-structural code validation and propulsion component and system performance testing. The desired characteristics for research sensors are high accuracy, high reliability, and survivability. Increasingly hostile measurement system environments make the achievement of these characteristics a major challenge. Measurements of current interest include material surface temperature, strain, heat flux, gas temperature and gas species.

W. Dan Williams
(216) 433-3725

High Temperature Electronics Technology — Development of silicon carbide-based, solid-state electronic device technology for high temperature, high radiation, and high power applications, such as advanced aerospace propulsion and power systems. Basic and applied research efforts include silicon carbide crystal growth techniques and all areas of device fabrication technology.

W. Dan Williams
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INTERNAL FLUID MECHANICS

Computational Fluid Mechanics
Development and application of new techniques for analysis of subsonic, supersonic, and hypersonic aerospace propulsion system flows associated with inlets, nozzles, compressors, turbines, combustors, augmentors, and rocket systems. Emphasis is on numerical methods with greater accuracy and significantly increased convergence rates. Of increasing importance are computational strategies using such concepts as multiblock grids and zonal approaches combining two or more numerical methods. Three-dimensional turbulent flow fields with emphasis on turbulence models are of continuing interest. An expanded and focused effort on developing, validating, and applying advanced turbulence models for propulsion flow physics is a growing research activity.

Louis A. Povinelli
(216) 433-5818

Computational Technology — Development and application of advanced computer hardware and software to the simulation of flows associated with aerospace propulsion components and systems. Included in the scope of the research is the synthesis and benchmarking of parallel computer architectures and algorithms for solving 3-D steady and unsteady flow problems, the use of expert systems as intelligent interfaces to large computer codes, the use of parallel processing and interactive graphics techniques for on-line visualization of computation results, and experimental data and improved data handling software for distributed computing environments.

Richard A. Blech
(216) 433-3657

Experimental Fluid Mechanics
Experiments to verify selected fluid mechanics computations and to advance understanding of flow physics, heat transfer, and combustion processes fundamental to aerospace propulsion. Experimental data are analyzed to aid development of aerothermodynamic models embracing combustion thermodynamics, reaction chemistry, and turbulence. State-of-the-art experimental facilities, instrumentation, and data acquisition, reduction, and analysis methods and facilities are employed.

Louis A. Povinelli
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AERONAUTICAL PROPULSION SYSTEMS

Airbreathing Propulsion Research and Technology for Hypersonic Vehicles — Analytical and experimental research in airbreathing propulsion systems for hypersonic flight and their integration with the airframe. Work includes analysis and test on inlet, nozzles, combustors, and other critical components. Experimental efforts include design and model and instrumentation. New theoretical flow analyses, which include 3-D shock/boundary layer interactions, are applied to the design and evaluation of experiments. Work is focused upon turbine-engine-based systems and combined-cycle systems and the integration and optimization of propulsion systems to enable revolutionary advances in vehicle system performance.

Frank D. Berkopac
(216) 433-3400

Emissions Technology — Experimental and analytical research to advance the understanding of emissions formation in combustion processes in subsonic and supersonic gas turbine aircraft engines. Research includes experiments in flame tube and sector combustors using advanced diagnostics. Analytical work involves using computer codes to predict combustion emissions and compare with on-going experimental results. State-of-the-art experimental facilities, instrumentation, analysis methods and computational facilities are employed.

Richard W. Niedzwiecki
(2l6) 433-3407

Aircraft Icing — Analytical and experimental efforts devoted to developing novel concepts for aircraft ice protection, and fundamental experiments to understand and model the physics of ice formations. Changes in aircraft performance with ice buildup on unprotected components are quantified.

Lewis Research Center

Extensive aerodynamic and thermodynamic numerical models are developed and utilized. Interdisciplinary efforts are devoted to developing instruments to characterize icing cloud properties, measure ice accretion on surface, and detect changes in aircraft performance in icing conditions. Experimental research is conducted with a specially equipment Twin Otter aircraft and in the Lewis Icing Research Tunnel, the largest refrigerated icing tunnel in the world.

Haeok Lee
(2l6) 433-3900

Aircraft Power Transfer Technology — Power transfer technology for advanced propulsion drive systems having higher power-to-weight ratio, longer life, higher reliability, lower noise, and higher efficiency. Areas under study include design optimization, new gear arrangements and tooth forms, materials, lubrication, and cooling. New analytical tools for stress analysis, vibration, lubrication, and high-speed gears are being developed. A full-scale helicopter transmission test rig is available, as are facilities for fundamental studies of lubrication, endurance, efficiency, noise of spur and bevel gears, and planetary gear sets.

John J. Coy
(2l6) 433-39l5

Low Noise Nozzle Technology — Analytical and experimental research on exhaust nozzle aerodynamics and acoustics for high speed commercial transport applications. The goal is to achieve takeoff noise levels competitive with the best subsonic engine technology. experimentally in large dedicated facilities where aerodynamic performance, near and far field acoustic performance, and flow details via advanced flow diagnostics can be determined.

Bernard J. Blaha
(2l6) 433-3933

Turbomachinery Technology — Research to advance turbo–machinery technology for gas turbine engines for a wide range of civil and military applications. Areas addressed include advanced axial and radial compressors and turbines as well as innovative components such as wave rotors. Research interests include cavity flows as well as main stream flows. Turbine research includes internal coolant flows and film cooling. Involved are flow visualization, detailed flow field and heat transfer measurements, computer code development, and performance modeling.

Lawrence J. Bober
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Fan/Propeller Aerodynamics and Acoustics — Analytical and experimental investigations of the aerodynamics and acoustics of turbofans for subsonic and supersonic civil transports. Advanced CFD, analytical, and Computational Aeroacoustics (CAA) methods are applied and compared to experimental data from model scale tests in aeroacoustics wind tunnels. Noise predictions are made using acoustic analogy models in conjunction with aerodynamic predictions. Aerodynamic modeling emphasizes combined effects of fan, nacelle and core flows on system performance and acoustic radiation. New fan and jet noise reduction concepts are developed and evaluated.

John F. Groeneweg
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High Performance Computing and Communications/Numerical Propulsion System Simulator — Development of a propulsion system simulator involving the integration of disciplines, components, and high performance computers into high level software environment. Of particular interest is the structuring of object oriented component models within a data flow control network. The numerically intensive component models will employ various parallel processing strategies to speed the overall system processing times. Various algorithms will be explored to solve complex geometry, time varying, engine system problems on a heterogeneous network of computers.

Isaac Lopez
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MATERIALS

Microgravity Materials Science
Fundamental research to understand the effect of gravity on materials processing as it influences convection, buoyancy, sedimentation, and hydrostatic pressure. Central to this effort is the Microgravity Materials Science Laboratory, which is used by scientists to develop experiments for eventual flight on the Space Shuttle. The laboratory develops advanced flight hardware and supporting equipment for process-

ing and analysis of metals, ceramics, glasses, and polymers. Areas of research include directional significant portion of this effort is being directed to computational modeling of growth processes as they are influenced by gravity. The laboratory includes an extensive computational and graphical display facility.

Thomas K. Glasgow
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Ceramic-Matrix Composite — Development of structure/processing/property relationships of ceramic-matrix composites including fibers and fiber coatings for high-temperature, high-reliability requirements for advanced aerospace propulsion and power applications. Various processing approaches, including polymer pyrolysis, melt infiltration, and sol-gel processing, are being pursued. Properties of interest include flaw distribution, phase morphology, strength, toughness, crack initiation and propagation characteristics, and resistance to environmental attack.

Stanley R. Levine
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Tribology & Surface Science — Research to gain a fundamental understanding of the lubrication, adhesion, and wear phenomena of materials in relative motion that meet increased speed, load, and high temperature demands of advanced aerospace propulsion and power systems. Liquid, solid and vapor phase lubricants are formulated and characterized. Surface and interface chemistries and morphologies as well as tribological behavior are examined in situ using a variety of techniques including Auger electron and x-ray photoelectron spectroscopy, infrared and Raman microspectroscopy, secondary electron and atomic force microscopy and profilometry.

Mary V. Zeller
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Polymers and Polymer Matrix Composites — Development of advanced polymers and polymer matrix composites for use in aerospace propulsion and power and space communications systems. Areas of research include polymer synthesis, characterization, and processing; composite processing, characterization and evaluation; interface studies; polymer/composite aging and life prediction; and determination of structure/property relationships. Research is interdisciplinary and involves work in organic and polymer chemistry, physics, chemical engineering, materials science and engineering, and mechanical engineering.

Michael A. Meador
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Environmental Durability of Advanced Materials — Research to understand the mechanisms of material degradation and to develop approaches to improve the durability of material systems for advanced turbines. Of particular interest are high temperature chemistry, environmental effects and the development of coatings for metals, intermetallics, and ceramics and their composites. Chemical vapor deposition (CVD), physical vapor deposition, and plasma spray processes are used in developing TBC and in environmental degradation studies.

Leslie A. Greenbauer-Seng
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Metallic Materials — Development of structural metallic materials for aerospace propulsion systems is emphasized. Intermetallic compounds, superalloys, copperalloys, and composites are being studied for improved performance, higher temperatures, greater durability, and lower cost. Microstructure/property relationships are being microscopy techniques are employed.

Michael V. Nathal
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STRUCTURES

Advanced Composite Mechanics
Research for development of theories, computational algorithms, and requisite computer codes for the mechanics, analysis, and design of propulsion structures made from high temperature composites. Of interest are polymer matrix, metal matrix, ceramic matrix, and carbon-carbon composites. Research focuses mainly on specialty finite elements for micromechanics and laminate theory; improved theories for life and durability prediction under hostile environment and long time exposure effects; probabilistic composite mechanics; and integrated computer programs for component-specific analysis and design, progressive fracture, acoustic fatigue, damping and high-velocity impact. Selective experimental research is conducted in support of theoretical developments.

Christos C. Chamis
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Concurrent Engineering Simulation — Research for developing integrated software packages for the computational simulation of multidisciplinary procedures through which propulsion structural systems are developed, conceived, designed, fabricated, verified, certified, installed, and operated (concurrent engineering). Of interest are simulation models and software packages which consist of: (1) workstations with discipline-specific modules, dedicated expert systems, and local databases; (2) a central executive module with a global database with communication links for concurrent interaction with the multidiscipline workstation; (3) unsupervised-learning neural nets; (4) adaptive methods for condensing and incorporating information as the system evolves; (5) zooming methods; (6) graphic displays; and (7) computer-generated tapes for numerically controlled fabrication machines.

Christos C. Chamis
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Probabilistic Structural Mechanics — Research for developing probabilistic structural mechanics, solution/computational algorithms, and requisite computer codes to quantify uncertainties associated with the parameters and variables required for structural analysis and design for both serial and parallel composites. Research focuses mainly on developing probabilistic theories and models for coupled thermal-mechanical-chemical-temporal structural behavior of propulsion structures made from high temperature materials and including metal matrix, ceramic matrix, and carbon-carbon composites and implementation in serial and parallel machines.

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Computational Structures Technology — Development, integration, and demonstration of technology to enhance the role of computational modeling in the design and development process for propulsion and power system structural components. Efficiency and credibility of computational modeling are of concern so technologies that streamline the design/analysis process as well as improve the fidelity of computational predictions are of interest. Specific areas of interest include computer-integrated simulation, multi–disciplinary computational mechanics, design optimization, and artificial intelligence. Simulation includes object-oriented technology, information models, product schema, distributed computing, virtual reality, and human interfaces. Computational mechanics includes fundamental mechanics principles, discrete solution methods, and parallel computing algorithms. Design optimization includes mathematical programming and optimality algorithms, heuristic methodology, and multidisciplinary design. Artificial intelligence includes expert systems and neural network applications.

Dale A. Hopkins
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Structural Dynamics — Development of fundamental methods for predicting and controlling the dynamic response and stability of aerospace propulsion and power systems. This includes analytical and experimental studies of the aeroelastic response of bladed disk systems, and both active and passive methods for controlling the vibration and stability of high-speed turbomachinery. Actively controlled bearing supports, particularly magnetic bearings, are being developed. New seal concepts are being evaluated and design methods developed. Technology for long life mechanical components for space mechanism designs is being researched. Advanced computational methods for analyzing multi-component dynamic systems are being applied.

George L. Stefko
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Structural Integrity — Research to assure integrity and reliability of aerospace propulsion and power systems and structural components. Areas of emphasis include interrogational methods for avoiding catastrophic fracture, fault-tolerant design, defect assessment, and residual life prediction. Comprehensive life prediction models are sought that incorporate complex stress states, nonlinear material characteristics, microstructural inhomogeneities, and environmental factors. Structural integrity is verified by nondestructive characterization of microstructure, flaw population, material morphology, and other relevant factors. Nondestructive evaluation is carried out using analytical ultrasonics, computed tomography, laser acousto-ultrasonics, and other advanced interrogational technologies. Modern computer science practices are exploited to the fullest, and emphasis is on advanced structural ceramics and composites. Integrated computer programs for predicting reliability and life of brittle material components are generated.

John P. Gyekenyesi
(216) 433-3210

Deformation and Damage Mechanics — Theoretical and experimental studies of deformation and damage mechanics are conducted to develop accurate methods for determining the deformation response and assessing the useful life of structural components operating at elevated temperatures. Typical examples include turbine vanes, blades, and disks; rocket motor combustion chambers, turbines, and nozzle liners; and hot sections of space and terrestrial power systems. Multiaxial, nonproportional, and nonisothermal loading conditions all prevail in such structures. Research focuses on developing:
(1) constitutive equations;
(2) numerical algorithms for analysis and design; and
(3) experimental validation of proposed theories and characterization of material response. Materials under investigation include polycrystalline, single crystal, and directionally solidified metals and their alloys: ceramics and metallic-, intermetallic-, and ceramic-matrix/ fiber reinforced composites.

J. R. Ellis
(216) 433-3340

Fatigue Life Prediction — Both analytical and experimental approaches are used to develop accurate techniques for predicting durability of aerospace components (turbine vanes, blades, disks, rocket nozzle liners, etc.) subjected to complex service loadings. These are subjected to severe cyclic loads in high-temperature environments. Temperatures are high enough to introduce creep, relaxation, metallurgical transformations, and oxidation. The behavior of materials and structures subjected to such environmental factors is studied in the laboratory, and techniques are developed to allow reliable life prediction in advance of service. Materials under investigation include monolithic alloys and ceramics; and newly developed metallic, intermetallic, and ceramic matrix/fiber reinforced composites.

Fully equipped, computer controlled test systems allow rationale behavior to be investigated under uniaxial and biaxial stress states. Also, advanced scanning electron microscopes, transmission electron microscopes, and microprobe facilities are available to investigate fatigue mechanisms at the microstructural level.

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SPACE PROPULSION TECHNOLOGY

Selected Liquid Rocket Propulsion Technologies — Research to better understand the basic physical and chemical processes in selected liquid rocket engine technologies that are synergistic to aeronautic propulsion. Disciplines include high-energy propellant chemistry, ignition, combustion, heat transfer and cooling in thrust chambers, nozzle flow phenomena, and performance. Of particular interest are the fundamentals involved in combustion, cooling, bearings, seals, expert systems applications to propulsion, and nonintrusive diagnostics. Work is conducted through detailed analytical and experimental programs to determine feasibility or applicability and to develop and validate models to describe the processes.

Ned P. Hannum
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Propulsion System Health Management — Research is required to develop improved and automated methods for the detection and isolation of anomalous behavior of propulsion systems and other launch vehicle subsystems. Efforts are currently focused on the Space Shuttle subsystems, Expendable Launch Vehicles, and X33/RLV propulsion and vehicle. Emphasis is on real time detection and diagnosis of propulsion systems and sensor failures, automated post-test diagnostics, and life usage information. Research opportunities include application of pattern recognition techniques for fault detection/diagnosis, analytical redundance for sensor validation, the development of generic feature extraction algorithms, automated diagnosis using expert system and model-based reasoning, and the development of quantitative and qualitative models for fault prediction.

Sol H. Gorland
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Lewis Research Center

On-Board Propulsion — This area includes extensive research and development efforts on high performance electric and chemical propulsion system concepts that are candidates for applications ranging from precision positioning of microspacecraft to primary propulsion for planetary exploration. For electric propulsion, electrothermal, electromagnetic, and electrostatic thruster systems are considered with an emphasis on miniaturization for 21st century missions. The low thrust chemical effort focuses on high performance storable bipropellant engines, green monopropellant and bipropellant systems, and miniaturized systems for microspacecraft. Efforts range from basic research to focused development. In addition to thruster system development, heavy emphasis is placed on the identification and resolution of integration issues critical to the user community.

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POWER TECHNOLOGY

Photovoltaic Space Systems — Fundamental and applied research to increase the efficiency, reduce the weight, and extend the life of solar cells for space applications. Emphasis is on III-V compound solar cells and thin film materials systems. Activities include materials studies; investigations of radiation damage effects; device design, fabrication, and testing; and the development of related component technologies such as cell contact metallurgy and optical concentrators.

Dennis J. Flood
(216) 433-2303

Space Environmental Interactions — Research on electrostatic and electromagnetic effects in space systems and instrumentation (induced by interaction with space plasma and field environments) and on the characterization of local plasma and field environments around large space systems. Effects include surface and bulk dielectric charging, plasma sheath development, current collection from plasma, arcing, and the stimulation and propagation of disturbances. Research disciplines: plasma, solid-state, and surface physics, electromagnetism, and space system design fundamentals.

Dale C. Ferguson
(216) 433-2298

Solar Array Power — New or improved planar and concentrator array technologies, components, and concepts for small spacecraft are being developed that are efficient, stowable, lightweight, long-lived, and less costly than present systems. Array design features of interest include optical, electrical, thermal and mechanical elecments. Test, analysis and development activities can also support large spacecraft arrays including structural analysis of deployment mechanisms, testing system operation in simulated space environments, and studies of new array concepts.

Cosmo R. Baraona
(216) 433- 5301

Electrochemical Space and Storage — Development of advanced technology to increase the life and energy density of energy storage systems and fuel cells. Emphasis is on nearer-term nickel-hydrogen, metal-hydride, lithium ion and hydrogen-oxygen regenerative fuel cell systems, with exploratory efforts being given to more advanced high-temperature ionic conductor systems. Pre-prototypes of advanced battery systems are being designed, built, and tested.

Marvin Warshay
(216) 433-6126

Space Power Management and Distribution Technology — Technology development to control the generation and distribution of electrical energy in aerospace systems and to define enabling technology for future aerospace power systems. Advanced electrical power systems and circuits such as semiconductor power electronic building blocks, advanced magnetics to facilitate the development of switchgear converters, motor drives for future space and aircraft systems, electrochemical devices for actuation and energy storage flywheels are also under active investigation. These components provide core building blocks to construct modular power systems which are analyzed using various design and simulation tools.

James F. Soeder
(216) 433-5328

Power Systems Technology — Program management and technology for efficient, compact, lightweight, longlife power systems from tens of watts to megawatts for small spacecraft; high altitude, long endurance unmanned air vehicles; and clean car/super car applications. System and mission studies for space, terrestrial, automotive and aero power systems are conducted to identify requirements and technology needs in the areas of energy conversion, thermal management, power conditioning and control, materials and environmental effects.

James E. Dudenhoefer
(216) 433-6140

Stirling Dynamic Power and Refrigeration Systems — Development of technology to explore the unique potential of the Stirling cycle engine and heat pump for both space and terrestrial applications. Principal emphasis is on developing the free-piston Stirling engine for space-power systems and advanced technologies for cryogenic space refrigeration systems. Among the areas of research are oscillatory flow and heat transfer, heat pipes, materials, non-contacting bearings, dynamic balancing, linear alternators and motors, and insulation.

James E. Dudenhoefer
(216) 433-6140

Power Materials Technology — Development of new or improved environmentally durable power materials, high emittance radiator surfaces, high reflectance or transmittance solar concentrators, high thermal conductivity materials, and high electrical conductivity composites. Evaluations of func–tional performance and durability are conducted for exposure to atomic oxygen, ultraviolet radiation, vacuum thermal cycling, and effects of interactions with lunar and Martian dust.

Bruce A. Banks
(216) 433-2308

Solar Dynamic Power Systems — Development of technologies for lightweight, high efficiency solar thermal power systems. Present emphasis is on the advancement of solar concentrator and heat receiver technologies. Specific concentrator emphasis is related to both rigid and inflatable lightweight structures, high reflectance surfaces, and protective films. Heat receiver emphasis is on a heat pipe cavity design with thermal storage. A system conceptual design in 1997 will define advanced solar dynamic technologies required for future space applications.

James E. Calogeras
(216) 433-5278

Thermal Management Technologies — Analytical and experimental efforts to develop the technologies for high performance heat transport components and systems. Concepts include an all silicon multichip module with integrated heat exchanger for space-based data processing as well as motor control for terrestrial electric vehicles. Zero gravity experiments are being done to demonstrate the feasibility of direct immersion heat pipes for cooling electronics in space. Low mass graphite/aluminum radiators are being built for commercial as well as government applications. A test facility has been built which can evaluate steady state as well as transient performance of high temperature, high power heat pipes.

Karl W. Baker
(216) 433-6162

SPACE COMMUNICATIONS TECHNOLOGY

Satellite Networks and Architectures — Studies of advanced space communications to define and enable future network architectures for commercial and NASA applications. Studies include investigation of standards and interoperability issues related to the use of advanced satellite systems with terrestrial networks (especially the Internet), development of new communications system architectures and networking concepts, and development of satellite-friendly protocols. Specific areas of interest are Asynchronous Transfer Mode (ATM), Transmission Control Protocol/Internet Protocol (TCP/IP), and applications such as digital video. Also involved are computer modeling of telecommunications networks and simulation of satellite/ terrestrial networks using OpNet or Bones.

Kul B. Bhasin
(216) 433-3676

Vacuum Electronics — Research on vacuum electronics to improve the efficiency, operating life, and communications qualities of electron beam devices for use in space communinetic/electrodynamic computer modeling and design, application of microfabrication to vacuum devices, and microwave power modules. State-of-the-art experimental and computational facilities are available.

James A. Dayton, Jr.
(216) 433-3515

Lewis Research Center

Digital System Technology — Application focused research and advanced digital technology development for space communications in the areas of modulation and coding, onboard processing, interoperable satellite/terrestrial networks, and intelligent systems applications. Specific technologies of interest include: bandwidth and power efficient digital modems and codecs; interoperable processing satellite architectures; onboard circuit and packet switching; and intelligent assistance for autonomous spacecraft operations.

Edward J. Petrik
(216) 433 3493

Solid State Technology — Research and development of advanced microwave circuits and the technologies required to integrate individual circuit components into microwave subsystems. Research is focused on solid state circuits for transmit and receive modules in the frequency range of 2-110 GHz. Specific technologies under development include planar transmission lines, passive circuit elements, device modeling, electromagnetic computer modeling, material growth, material characterization, high temperature superconductor microwave circuits, and multilayer microwave circuit components and packaging techniques. State of the art experimental and fabrication facilities include automatic network analyzers, room temperature and cryogenic probe stations, and a clean room.

James A. Dayton, Jr.
(216) 433-3515

Antenna Technology — Research and advanced development of phased arrays for space communication systems for commercial applications and NASA missions. Emphasis is on development of K/Ka-band arrays/array feeds in which distributed monolithic microwave integrated circuit (MMIC) devices provide amplitude and phase weighing. Principal thrusts are on MMIC integration technologies, including MMIC packaging; printed circuit radiating elements and distribution media, beam forming/combining networks and fiber optic links in arrays. Systems and technologies for multiple beams, including digital beamforming are also of interest. State-of-the-art antenna metrology facilities are available.

Charles A. Raquet
(216) 433-3471

SPACE EXPERIMENTS

Microgravity Science and Applications — Basic science experiments designed to capitalize on the microgravity environment of the Space Shuttle in the areas of combustion, materials science, fluid physics and transport phenomena. Science requirements and conceptual designs are developed using ground-based 2.2 second and 5 second drop towers and a DC-9 aircraft. New diagnostic instruments are also developed. Activities culminate in the design, fabrication, and flight of space experiments.

Jack A. Salzman
(216) 433-2868

In-Space Technology Experiments
In-space experiments to support advancement of the technology base in the areas of fluid management, energy systems and thermal management, and satellite communications. Areas of investigation include on-orbit fuel storage and transfer, low-gravity fluid behavior and thermal processes, instrumentation, and space plasma interactions. While ground-based precursor studies are pursued, emphasis is on the definition and development of cost-effective flight projects that yield results otherwise unobtainable through ground-based experiments or analysis.

Penni J. Dalton
(216) 433-5223

George C. Marshall Space Flight Center

Marshall Space Flight Center, AL

The Marshall Space Flight Center offers opportunities for original work in many areas of physical sciences, mathematics, and engineering. Theoretical and experimental research is greatly enhanced by the ready access to computers, including the Cray XMP.

Before preparing your proposal, prior discussion with a Center researcher is recommended. In general, Marshall advisers are interested in collaborative efforts with students and their university advisers and will look favorably on proposals which indicate that research time will be spent on-site at the Center.

Program Administrator:

Ms. Ernestine Cothran
University Affairs Officer
Mail Code ES01
NASA Marshall Space Flight Center
MSFC, AL 35812
(Federal Express Address:
Building 4481 / Room 101)
(205) 544-0649

ASTRIONICS LABORATORY

Electrical Systems — Activities include development of photovoltaic array systems, battery technology and application, and electrical power system automation. Research is conducted in improved photovoltaic cell design and testing. On-site resources include a photovoltaic test laboratory for simulation of on-orbit conditions. Research and application of electrochemistry is utilized to improve space flight batteries with life cycle testing and destructive physical analysis. Artificial intelligence approaches are used to support electrical power system automation.

R. Bechtel
(205) 544-3294

Electronics and Sensors — Research, design, and development of activities are conducted on electronic control systems and measurement sensors for the guidance, navigation, and control of space vehicles. Subjects addressed are sensors, transducers, control actuators, reaction wheels, and pointing systems.

L. J. Cook
(205) 544-3440

Optical Systems — Opportunities exist for research, development, and application of technology in the following areas: coherent lidar systems (both gas and solid-state technologies), target and detector calibration, transmitter evaluation, signal processing atmospheric propagation and system modeling; video/film camera systems, including imaging systems development, fiber optics, video compression, radiometry, film camera, and video system evaluation; and optical design, fabrication and testing including straylight analysis and testing, performance analysis, coating metrology, precision engineering and binary optics.

J. Bilbro
(205) 544-3467

Audio Systems — Design, development, and evaluation of flight audio communications systems are performed in support of ongoing and future programs. Specific areas of interest include digital signal processing and encoding techniques, voice synthesis and recognition, and the effect on background noise on intelligibility.

P. Clark
(205) 544-3661

Communications Systems — Test facilities are available to pursue research and development of antenna components and systems. These facilities include a fully automated kilometer pattern test range and a shielded anechoic chamber with 3.7 meter diameter quiet zone and supporting test equipment operating up to 60 Ghz. Other areas of interest include high-power, solid-state transmitters and spread spectrum receivers.

L. Bell
(205) 544-3678

Software Systems — An area of high interest is the automatic generation of digital computer code from structured requirements. An area of particular interest is definition of a set of integrated computer aided support tools for software development from requirements phase through validation for embedded computer systems. Another target area of research and development is artificial intelligence techniques and tools to aid in fault diagnosis, load management, and scheduling for flight systems and sub-systems.

R. Stevens
(205) 544-3728

Battery Cell Analysis — Opportunities exist for research into the development of chemical and electrochemical techniques for analysis of aerospace battery cells. These include the modification of analytical techniques to minimize the amount of chemical waste produced and the development of electrochemical impedance spectroscopy as a tool in cell analysis. An important task in the latter is the development of an electrochemical model to be used in interpretation of spectra.

D. H. Burns
(205) 544-4807

MATERIALS AND PROCESSES LABORATORY

Major research efforts are underway in physics and chemistry of metallic and nonmetallic materials in critical environments (cryogenic to high temperature) and new and improved techniques for developing spacecraft hardware. Comprehensive research and development activities are pursued in qualification and testing of materials and processes.

Space Environmental Effects on Materials — Evaluation of material is accomplished in simulated space environments involving vacuum, temperature, electron/proton, and UV irradiation, atomic oxygen, and micrometeoroid impact. The effects of outgassing products of materials on weight loss, strength loss, surface properties, and redeposition and condensation on other items are being studied. Studies involving lubrication and surface physics of bearings in space and in rocket propulsion components are also being conducted. Research and development in new nondestructive evaluation (NDE) methods/processes and instrumentation are encouraged.

P. Schuerer
(205) 544-2481

Metallic Materials — Development of advanced materials for special applications in propulsion systems is ongoing. The materials include aluminum-lithium metal matrix composites and hydrogen resistant alloys. The effect of high-pressure, high temperature hydrogen on metals is an area of special emphasis. Research in microstructural analysis methods is being accomplished in support of failure analysis and fracture mechanics programs. Methods are being developed for quantitatively determining the state of corrosion, stress corrosion, and hydrogen embrittlement of alloys. Several ongoing efforts exist relative to advanced welding methods, intelligent processing, robotics, and the development of sensors for chemical and welding process controls.

P. Munafo
(205) 544-2566

Nonmetallic Materials Research
Opportunities exist to develop and modify polymers for adhesive, elastomers, insulators, composite matrices, and molding and extrusion compounds for use in spacecraft hardware and in special environments. Organic composite such as carbon-carbon and carbon-resin are being developed for structural applications to reduce mass or for high-temperature applications such as rocket engine nozzles and leading edges. Research and development activities are being conducted to evaluate new analytical chemistry techniques or instrumental methods to assist in determining material properties under various temperatures, pressures, and environments. Analysis of waste, ground, and storm waters, soils, air, etc. is performed in accordance with EVA guidelines. In addition, ceramics and glasses with special optical properties for use in spacecraft are being studied. Major research and technology efforts are underway in composite material fabrication, testing, and qualification for flight hardware application. Composite methodologies include automated filament winding and tape laying, pultrusion, tape warpping, fiber placement, and hand lay-up. Additional opportunities exist relative to the development, application, and evaluation of cryogenic and high temperature thermal protection materials used in association with both liquid and solid propellant rocket motors. Opportunities also exist in the development of environmentally acceptable cleaning materials for use in the

fabrication of components for launch vehicles.

C. McIntosh
(205) 544-2620

PROPULSION LABORATORY

Activities are directed toward the research, technology, and flight hardware development of propulsion systems for launch and space vehicles and support equipment. Areas of activity include liquid and solid propulsion and control systems for the Space Shuttle, space propulsion and support systems, advanced chemical and nuclear propulsion systems for future launch and space vehicles, and flight experiment and space station mechanisms.

Propulsion Division — Research and development is ongoing in liquid propulsion systems and reaction control systems. Activities include predicting, analyzing, designing, and evaluating propulsion system and launch vehicle performance, and establishing test, integration, and verification requirements for flight and test bed propulsion systems. Special emphasis areas are zero- and low-gravity propellant systems and Shuttle main propulsion systems.

L. Jones
(205) 544-7094

Propulsion Development Division — Activities involve research and development for mechanical subsystems such as propulsion feedlines, turbomachinery, combustion devices, thrust vector control, auxiliary propulsion, valves, actuators, controls, mechanisms, and environmental control and life support hardware. Another area of interest is establishing test, integration, and verification requirements for mechanical elements.

C. S. Cornelius
(205) 544-7130

Combustion Devices and Turbomachinery — Investigation of combustion stability, performance, and heat transfer of large rocket engine thrust chambers are of special interest. Techniques for understanding the failure and wear modes and improving the life or propellant cooled anti-friction heatings are needed for reusable rocket engines.

G. Young
(205) 544-7070

Test Division — Activities include experimental research and development testing of propulsion systems, subsystems, and components for space systems hardware. Current specific areas of interest relate to automated test control systems. A continuing interest exists for new and advanced instrumentation techniques.

R. L. Thompson
(205) 544-1247

Propulsion and Motor Systems Division — Research and development is ongoing in liquid rocket engines, solid motors, propulsion systems, and reaction control systems. There is continuing interest in solid and liquid propellant combustion, performance prediction, engine risk management, launch and space vehicle propellant and pressurization systems, hybrid boosters, and advanced engine health monitoring subsystems. Special emphasis area is zero and low-gravity propellant systems and combustion.

L. Jones
(205) 544-7094

C. Verschoore
(205) 544-6996

SPACE SCIENCES LABORATORY

Radar and Hydrometeorology Studies — This research is directed towards understanding precipitation processes and their relation to the larger scale environmental forcing. Cloud microphysics, precipitation processes, storm kinematics, and morphology studies are conducted using ground-based and airborne research data acquired during field campaigns. Ancillary data from satellite and airborne microwave and imaging remote sensor data are used to further describe the convective processes. Data collected from the operational National Weather Service WSR88-D (NEXRAD) network are used to develop climatological rainfall estimates and water budgets to study the interannual variability of rainfall and its relation to changes in the synoptic and general circulation. This research will lead to improved understanding of precipitation processes and algorithms developed for new satellite sensor suites.

S. Goodman
(205) 922-5891

George C. Marshall Space Flight Center

Hydrometeorology/Land Surface Interface — Earth's surface characteristics and their linkages to the atmosphere and hydrologic cycles are being analyzed and modeled using remotely sensed data. Measurements from satellite and aircraft sensors, in conjunction with *in situ* measurements, are used to study spatial and spectral resolution and temporal variability effects on determination of land surface energy fluxes, hydrometeorological characteristics, and biophysical components. The affects of spatial and temporal scale on land surface interface processes is assessed using mesoscale hydrometeorological and Global Circulation Models. Geographic information systems play an important research role in integrating and modeling remote sensing and ancillary data for analysis of the spatial and temporal dynamics of land surface hydrometeorological interactions.

D. Quattrochi
(205) 922-5887

Global Passive Microwave Studies
The Defense Satellite Meteorological Program has launched a series of satellites with passive microwave sensors. These instruments (Special Sensor Microwave Imager, Special Sensor Microwave Temperature-1 and Special Sensor Microwave Temperature-2)are used to detect and measure atmospheric temperature and moisture profiles, bulk atmospheric water vapor and cloud liquid water amounts, precipitation, and land surface temperature and type. Future research in the usage of one or a combination of these data sets for global multi-year or seasonal assessments of hydrometeorological parameters is desired.

M. Goodman
(205) 922-5890

Infrared Water Vapor Measurements — Water vapor is a key component of the Earth's hydrologic cycle. This research focuses on the measurement of atmospheric water to determine bulk water vapor variability and to infer upper-level winds by tracking of water vapor features. Geostationary satellite data from the GOES - VAS and GOES Next satellites are used for local, regional, and hemispheric analysis in support of budget and model studies of the hydrologic and energy cycles.

G. Jedlovec
(205) 922-5966

Aerosol Backscatter and Lidar Studies — The research focuses on the assessment of global patterns of aerosol backscatter, the calibration and characterization C02 Lidar systems, and the development of aircraft-and space-based Lidars for the determination of regional and global winds. major experimental efforts have included a network of C02 Lidar stations, intensive field campaigns, and a host of aerosol sensors. Laboratory facilities exist to calibrate and characterize Lidar systems. A multi-agency program to develop and fly an airborne Doppler Lidar (MACAWS) will provide a wealth of unique measurements to support this research.

J. Rothermel
(205) 922-5965

Atmospheric Electricity Studies
The research is directed toward understanding the physical processes leading to the generation of electrical energy within thunderstorms, developing global lightning climatologies, and understanding the global electric circuit. Modeling, analytic, and observational approaches are used in these studies. Particular emphasis is placed on ground-, aircraft-, and satellite-based optical sensors to study the distribution and variability of global lightning activity. The recently launched Optical Transient Detector and future EOS instruments will play a major role in this research.

R. Blakeslee
(205) 922-5962

Microwave Measurements — Acquisition and analysis of aircraft and satellite microwave radiometer measurements lead to further understanding of the microphysical processes of precipitation systems and aid in monitoring global climate change. In this research, aircraft measurements are used to investigate the spatial and temporal structure of precipitation systems, improve inversion techniques for precipitation estimation, for the polarametric retrieval of surface wind velocity over oceans, and for increasing the understanding of heating profiles in tropical atmospheres. Pioneering work with the multi-year MSU satellite data sets are used for global temperature and precipitation studies.

R. Spencer
(205) 922-5960

Atmospheric Chemistry — Measurements of trace species and temperature in the upper troposphere, stratosphere, and mesosphere have been made from the Space Shuttle and other space platforms. These measurements are utilized to study the interactions between chemistry, dynamics, and radiation that are important in Earth's physical climate system. Especially important are the varying concentrations of stratospheric ozone that are determined by these interactions. This research effort utilizes space-based observations along with detailed models of the atmosphere to better understand the processes that determine stratospheric ozone, the interactions between the troposphere and stratosphere (including the role of water vapor), and the influence that human activities have on the atmosphere through the release of chemicals.

T. Miller
(205) 922-5882

Climate Diagnostics and the Global Hydrologic Cycle — Observational, numerical modeling, and analytical approaches are used to study the Earth's physical climate system. Diagnostic analysis of space-based observations are used to understand and validate models of global hydrologic cycle. Numerical models ranging in scope from atmospheric general circulation codes to mesoscale and cloud models are used to study water cycle processes and to quantify their role in climate. Sensitivity studies of climate models to surface boundary forcing, i.e., sea surface temperature, albedo and soil moisture anomalies are conducted. Simulations of remote sensors are used to understand how spacebased observations can be best applied to studying the Earth as a system.

X-Ray Astronomy — Experimental, observational, and theoretical research is conducted in x-ray astronomy and high-energy astrophysics. The experimental program concencrates on development of replicated x-ray optics, polarimeters, and hard-x-ray imaging detectors operating from I keV to above 100 keV using microscrip and liquid-xenon technologies. Observational and theoretical specialties comprise the study of compact objects (neutron stars and black holes), cooling flows in clusters of galaxies, and astrophysics of high-temperacure plasmas. Opportunities include participation in balloon flights of sensors, analysis of data from the x-ray polarimeter on SPECTRUM-X (launch 1996) and other satellites, theoretical studies of physical processes in high-temperature astrophysical plasmas, and observations of clusters of galaxies and the Sunyaev-Zeldovich effect.

M.C.Weisskopf
(205) 544-7740

Space Plasma and Upper Atmospheric Physics — We seek to better understand, and ultimately to predict, the flow of matter, momentum and energy through the region in which the Sun-Earth connection is made: the Earth's magnetosphere and ionosphere. We further seek to better understand basic physical processes that effect the operation of spacecraft in space and that are important in astrophysical plasmas; for example cometary, planetary, and stellar upper atmospheres. Plasma and gas dynamic processes are studied by means of in situ plasma and neutral particle measurements, and by remote optical and electromagnetic sensing of the constituent plasmas and gases. Activities include design, development, and calibration of flight instrumentation, with analysis and interpretation of the resulting data in terms of physical models.

T. Moore
(205) 544-7633

Solar Physics — The influence of the magnetic field on the development and evolution of solar atmospheric structure is studied. The primary data are vector magneto–grams obtained at Marshall's Solar Observatory. These observations are complemented by theoretical studies to characterize the nonpotential nature of these fields. This includes the development of MHD (magnetohydrodynamic) codes designed to simulate both coronal and large scale interplanetary dynamic. Instrument development programs in optical polarimetry, grazing, and normal incidence X-ray optics, and imaging detectors are being pursued.

J. Davis
(205) 544-7600

Gamma Ray Astronomy — Gamma ray astronomy is performed with balloon-borne and orbiting instruments designed and developed at MSFC. The research includes experiments covering the 30 KeV to 10 MeV region to study gamma ray bursts and other transients sources, pulsars, and to study the variability and spectra of known sources. Present activities include analysis of data from the Burst and Transient Source Experiment on the Gamma Ray Observatory, and the development of new balloon-borne instruments. Studies of the gamma ray background in the atmosphere and on spacecraft are made with calculations and with measurements on Spacelab, LDEF, and GRO.

G. Fishman
(205) 544-7691

Cosmic Ray Research — Cosmic ray research at MSFC emphasizes the study of the chemical composition and energy spectra of cosmic ray nuclei above 10^{12}eV(JeV). Study of the interactions of heavy cosmic ray nuclei are also carried out to determine the behavior of nucleus interactions and to search for evidence of new states of nuclear matter. The research is carried out with emulsion chambers and with electronic counters, exposed on balloons at about 40 kilometers altitude for up to two weeks. Research includes laboratory work, data analysis, particle cascade calculations, and correlative accelerator experiments.

T. Parnell
(205) 544-7690

Microgravity Solidification — Theoretical and experimental research is conducted on the effects of gravity on the crystal growth or solidification of materials including semiconductors, metals, alloys, polymers, model systems, etc. Both the preparation and the characterization of materials are important. The areas of research include solid-state physics, surface physics, solidification phenomena, fluid modeling, analysis of crystal growth, and characterization techniques such as optical, X-ray, and electron microscopy. In addition to well-equipped laboratories for these activities, the division operates a drop tube 100 meters high.

F. Szofran
(205) 544-7777

Biophysics — An opportunity exists to conduct research in the separation and purification of biological cells and proteins to develop a basic understanding of the separation phenomenon. The proposed research should include analysis of the fundamental behavior of a separation process by theoretical and/or experimental methods. A second activity involves laboratory and space experiments in protein crystal growth. High quality single crystals are required to obtain the three-dimensional structure of the proteins, and Shuttle space experiments confirm the advantages of the microgravity environment. Projects include experiments to define improved crystallization conditions and the analysis of crystals by X-ray diffraction.

D. Carter
(205) 544-5492

STRUCTURES AND DYNAMICS LABORATORIES

Pointing Control Systems — Tasks include pointing systems with performance of one milliarcsecond, ability to actively control structures with structural modes below the control frequency, use of fiducial light systems and unobtrusive sensors/effectors to stabilize large space structures, development of the theory of many control systems working on the same flexible structure, modeling and control of flexible multibodies with configuration changes, and momentum exchange control of very large objects, and wave front control by phases array mirrors.

H. Waites
(205) 544-1441

Control of Space Vehicles and Robotic Manipulators — Tasks include development of autonomous adaptive control algorithms for reusable launch vehicles and spacecraft during all flight phases included rendezvous, docking, reentry, and landing. Image processing/pattern recognition algorithms for target spacecraft identification and attitude determination (both stabilized and tumbling). Control systems for tethered spacecraft, spacecraft control system health monitoring, and adaptive control of flexible robotic manipulators.

N. Hendrix
(205) 544-1451

Liquid Propulsion Dynamic Analysis — Task include dynamic analysis, determination of damping methods, analysis of bearings, and dynamic balancing of high-speed turbomachinery. Topics of interest in control include rapid recognition of engine failure, detecting incipient failure, automatic reconfiguration of control components, and more accurate means to control propellant mixture ratio.

P. Vallely
(205) 544-1440

Structural Dynamics — Activities of interest are aerostructural modeling, vibration analysis, and load predictions using simulation of all environments, including propulsion, control, aerodynamics, and atmosphere. Probabilistic, as well as deterministic, approaches are used on the CRAY to simulate flight and obtain loads data. Enhanced dynamic analysis techniques are pursued.

W. Holland
(205) 544-1495

Structural Assessment/Structural Analysis — Opportunities exist for research in strength, stability, fatigue, and fracture mechanics analyses. Computationally intensive methods such as finite and boundary element analyses are used extensively. Practical enhancement methods are sought such as solution adaptive finite element modeling techniques. Technology improvement in analysis and computational methods which lead to development of practical engineering tools are encouraged. The CRAY computer is available for analytical analysis in conjunction with work stations.

C. Bianca
(205) 544-1483

Vibroacoustics — Mechanically and acoustically induced random vibration design and test criteria and response loads analytically derived using advanced computer techniques. Vibration, acoustic, and transient data from engine static firing and Space Shuttle flights are analyzed and categorized. Research opportunities include improved vibroacoustic environment prediction methods and high frequency vibration data analysis techniques.

J. McBride
(205) 544-1523

Structural Design Optimization/ Synthesis — In view of the need for lighter, stiffer, and stronger launch and space vehicle structures, new ways of designing structural systems are being sought. Research on the synergistic effects of assembly of structurally optimized elements and components is needed. Efficient and effective design methods and tools using numerical optimization, trajectory analysis, thermal analysis, loads, stress environments, and other critical criteria are needed.

P. Rodriguez
(205) 544-7006

Thermal Analysis/Liquid Propulsion Systems — Opportunities for research exist in thermal analysis of liquid propulsion system components, including integrated thermal/ structural analysis of turbine section and rotating components in high-pressure turbomachinery. Analytical results may be correlated to ground test data.

J. Owen
(205) 544-7213

Thermal Analysis/Solid Rocket Motor — Opportunities are available for research in thermal modeling and analysis of solid rocket motor thermal protection systems. Specific areas include the modeling of ablation processes involving a variety of material surfaces and the determination of heat transfer coefficients in radiative, erosive, and chemically reactive environments.

K. McCoy
(205) 544-7211

Thermal/Environmental Computational Analysis — Research opportunities are available in advanced thermal modeling and analysis techniques based on state-of-the-art graphics systems and software. Research is needed in methods of 3-D graphic modeling of thermal systems which are compatible with computational fluid dynamics and stress modeling.

G. Schunk
(205) 544-7221

Hypervelocity Impact Design and Analysis — Research opportunities are available in the design, analysis, and testing of advance hyper–velocity impact shields. Due to the increased space debris, more weight-efficient shields are needed for all future long-term space endeavors. Specific areas include ballistic limit predictions, impact and penetration effects, innovative shield designs for minimum maintenance, quick deployment/retraction shields, composite material shield design, novel shields, and damage prediction.

J. Robinson
(205) 544-7013

Computational Fluid Dynamics
Opportunities to develop and apply state-of-the-art computational fluid dynamic (CFD) methods to solve three-dimensional highly turbulent flows for compressible and incompressible, and reacting fluid states, and to provide benchmark CFD comparisons to establish code quality for subsequent application. Research is needed to assess significant aspects of the computational algorithms, grid generation,

chemistry and turbulence modeling code efficiency, and stability, etc.

P. McConnaughey
(205) 544-1599

SYSTEMS ANALYSIS AND INTEGRATION LABORATORIES

Configuration Management — Configuration management is an essential component of any successful engineering activity. Marshall projects tend to be both large and complex, requiring the efforts of teams of both NASA and contractor engineers. The level of control required by manned space flight makes configuration management a critical activity. Automated tools and improved methods are continually sought.

N. Foster
(205) 544-2425

Systems and Components Test and Simulation — Opportunities exist for the development, qualification, integration, and flight acceptance testing of space vehicles, payloads, and experiments. Neutral buoyancy simulations for training and development of extravehicular activity (EVA) techniques are performed. Thermal vacuum testing is conducted in a variety of chambers with capabilities to 1X10-7 torr and temperature ranges from 149C to +204C. Facilities exist to calibrate X-ray payloads and scientific instruments utilizing a 518-meter evacuated guide tube.

G. Hartsfield
(205) 544-6965

R. Stephens
(205) 544-1336

C. Reily
(205) 544-1298

Crystals Growth in Fluid Field and Particle Dynamic Evaluation
The Fluid Experiment System (FES) was developed to study low-temperature crystal growth of a triglycine sulfate solution in a low-gravity environment. Incorporated into the FES is a laser/optical system for taking holograms of crystal growth, fluid density, and temperature variations. Tasks include applying holographic and digitized image techniques to evaluating these holograms.

J. Lindsey
(205) 544-1301

MISSIONS OPERATION LABORATORY

Flight Operations — The Mission Operations Laboratory performs functions contributing to the performance of science in space, particularly focusing on development of space science operations capabilities. Payload operations are integrated premission and managed during the on-orbit execution in support of the science users. The operations control function includes command planning, control plans and procedures, and air-to-ground voice management. The data management function includes end-to-end flow analysis and management, requirements development for flight systems, and intercenter data requirements development. The mission planning function includes orbit analysis, mission timelining, flight design, and development of planning systems.

C. Owen
(205) 544-2017

Training/Training Systems — Training on payload operations is provided for the payload crew, payload flight controllers, and investigators using computer simulations, computer-aided training, mock-ups and/or engineering models. Continuous improvement requires that training methods and tools be assessed and updated on a periodic basis. These updates are based on improved capabilities/technology, current information relative to pedagogy, and lessons learned from previous training sessions.

D. Underwood
(205) 544-2191

Gloria Hullett-Smith
(205) 544-2050

Ground Support Systems — The Huntsville Operations Support Center is the ground facility that supports multi-project flight operations. The design and development function includes communications (voice, video, wideband data handling, and external information transfer), data acquisition and processing, payload and spacecraft commanding user work station data presentation, and facility support functions. Development includes prototyping new technologies to ensure state-of-the-art capabilities, with special emphasis on remote operations linking multiple ground facilities. The facility is managed and operated in support of project and user requirements.

K. Cornett
(205) 544-4321

Human Factors — Human factors analysis in support of flight and ground system development is performed using analytical tools as well as mockups in both 1-G and neutral buoyancy zero-G simulations. Human computer interface standards are developed and applied to flight crew tasks and evaluation of control and display devices. New, more effective man/machine interface techniques are evaluated and integrated into design and operational activities.

S. Hall
(205) 544-0517

Expert Systems — New software methods are needed to automate and simplify increasingly complex ground support tasks associated with spacecraft and payload flight operations. Reset projects are projected in the areas of automated analysis of engineering and operations telemetry, decision support, and trend analysis.

M. McElyea
(205) 544-2034

SAFETY AND MISSION ASSURANCE OFFICE

Reliability Engineering — Research and analysis are conducted to gain an understanding of complex physics of failure mechanisms with the Space Shuttle Main Engine. The use of statistical models, failure mode and effects analysis, and analysis of failure and anomaly reports, as well as applicable generic data, contribute significantly toward the research efforts.

F. Safie
(205) 544-5278

Quality Assurance Office — Research is performed in areas dealing with software quality control, nondestructive evaluation (radiography, ultrasonic, eddy current), critical process control, use and evaluation of inspection methods, and assessment of critical characteristics in inspection with respect to control of critical items.

P. Smith
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Systems Safety Engineering — Opportunities exist for research in the development and implementation of quantitative and qualitative techniques directed at the identification, evaluation, and control of hazards associated with complex space systems. This includes probabilistic risk assessment, fault tree analysis and applications, interactive hazard information tracking and closure systems, and the identification of conceptual approaches to establishing mission levels and requirements for various types of space missions.

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John C. Stennis Space Center

Stennis Space Center, MS

NASA's John C. Stennis Space Center (SSC), located near Bay St. Louis, MS, has grown into NASA's premier Center for development and testing of large rocket propulsion systems.

At Stennis, static testing is conducted on the same huge concrete and steel towers used from 1966 through 1970 to captive-fire all first and second stages of the Saturn V rocket used in the Apollo manned lunar landing and Skylab programs. Since 1975, the Center has been responsible for flight acceptance testing on the Space Shuttle's main engines. The data accumulated from these ground tests, which simulate flight profiles, are analyzed to ensure that engine performance is acceptable and that the required thrust will be delivered in the critical ascent phase of Shuttle flights. No Shuttle main engine can fly before it is tested at SSC. The goal of the Research and Development program, conducted in conjunction with the test program, is to significantly advance propulsion test technologies for both government and commercial propulsion programs. Other programs at SSC include the Commercial Remote Sensing Program, Earth System Science Research, and Technology Transfer.

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TECHNOLOGY

Propulsion System Testing Techniques, Simulation, Modeling, and Methodologies — Research opportunities exist to develop new, innovative techniques to conduct a wide variety of required tests for space systems, stages/ vehicles, subsystems and components. Computational Fluid Dynamics modeling and actual hardware testing might be better coupled or integrated. A flexible, dynamic fluid flow simulation and structural modeling graphic interface research tool is desirable for ground test programs of space propulsion systems. Technology development is needed for inexpensive ultra-high power pump drives and prime movers with low operational costs.

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Cryogenic Instrumentation and Cryogenic, High Pressure, and Ultrahigh Pressure Fluid Systems
Over 40 tons of liquefied gases are used annually in the conduct of propulsion system testing at the Center. Instrumentation is needed to precisely measure mass flow of cryogen's starting at very low flow rates up to very high flow rates at pressures to 15,000 psi. Research, technology, and development opportunities exist in developing instruments to measure fluid properties at cryogenic conditions during ground testing of space propulsion systems. Both intrusive and non-intrusive sensors, but especially non-intrusive sensors, are desired.

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LOX/GOX Compatible Materials
Liquid Oxygen (LOX) and Gaseous Oxygen (GOX) are prime oxidizers for liquid fueled rocket engines and present a danger in material handling. A major need exists for a group of LOX/GOX compatible materials for seats, seals, and solid lubricants for valve and pump components and other uses. Simple, effective, safe techniques to easily and cheaply test or qualify new LOX/GOX compatible materials is desirable.

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Vehicle Health Management/ Rocket Exhaust Plume Diagnostics — A large body of UV-Visible emission spectrometry experimentation is being performed during the 80 or more tests conducted each year on the Space Shuttle Main Engine at SSC. Research opportunities are available to quantify failure and wear mechanisms, and related plume code validation. Related topics include combustion stability, mixture ratio, and thrust/ power level. Vehicle health management/exhaust plume diagnostics experimentation may be readily conducted at the SSC Diagnostics Testbed Facility. Currently, some exploratory studies have been done with emission/absorption spectroscopy, absorption resonance spectroscopy, and laser induced fluorescence.

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Spectroscopy Technology for Propulsion System Testing — Numerous opportunities exist to advance spectroscopy technology for propulsion system testing. Only a relatively small portion of the electromagnetic spectrum has been investigated for use in propulsion system testing and exhaust plume diagnostics/vehicle health management.

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Active and Passive Non-intrusive Remote Sensing of Propulsion Test Parameters — The vast amount of propulsion system test data is collected via single channel, contact, intrusive sensors and instrumentation. Future propulsion system test techniques could employ passive non-intrusive remote sensors and active non-intrusive remote sensing test measurements over wide areas instead of at a few discrete points. Opportunities exist in temperature, pressure, stress, strain, position, vibration, shock, impact, and many other measured test parameters. The use of thermal infrared, ultraviolet, and multi-spectral sensors, imagers, and instruments is possible through the SSC sensor laboratory.

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Ground Test Facilities Technology — Ground test facilities seldom keep pace with propulsion system development programs partly because the facility is usually designed before the test requirements are known and because test facilities are usually extant and inflexible. An innovative approach to producing flexible, easily adaptable ground test facilities is highly desirable. Research opportunities are also available for developing uncertainty models of test facility systems. Opportunities exist for modeling Thermal Energy Storage systems such as the pebble-bed heater at SSC. Additional opportunities exist in developing altitude simulation and self-pumping diffusers for large rocket propulsion system tests.

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Thermal Protection and Insulation Systems — The test of liquid rocket systems employ very large flame buckets and diffusers to control, deflect, cool, condition, and reduce the sound level of the plume. Innovative thermal protection tiles, coating, or materials, and insulation systems could result in significant savings. Cryogenic lines and vessels typically require expensive vacuum jackets, expansion joints, and devices to maintain the fluids at the required extremely cold and some time high pressure conditions. Better thermal protection and insulation systems might do the same tasks cheaper and require little or no maintenance.

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Leak Detection, Sensors, Quantification, and Visualization — Opportunities exist in leak detection technology to determine what is leaking, how much is leaking, where is the source of the leak, and to model and visualize the extent of the effected area. Often hydrogen leaks are the topic of concern because of the explosive nature of hydrogen, and the expense for repairing the leak when eventually found. However, other hazardous and non-hazardous fluid leaks are also of concern. Leaks can occur in compartments and locations where inert gas backgrounds such as nitrogen or helium are present. Portable and/or non-intrusive leak pinpointing techniques are also of interest.

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Material and Fluid Science — In some cases the basic physics of the material, heat transfer, thermal or fluid science is not understood well enough to model the propulsion system test facility to the required level of sophistication. As more advanced systems are developed, fundamental data is needed to properly design the test facilities. Characterization of collapse factor at pressurant and cryogenic fluid interface, cavitation, and thermal stratification are areas of interest. Particular attention is needed to develop materials for LOX service at extreme pressures and to resist hydrogen embrittlement. Research opportunities are available at the 210,000 gallon liquid hydrogen barges, High Pressure Gas Facility, Gas and Materials Analysis Laboratory, the Advanced Sensor Development Laboratory, the Diagnostics Testbed Facility and a planned Cryogenic Conditions Testbed.

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Propellant and Pressurants Conservation, Recycling, and Energy Conservation — Large quantities of cryogenic fluids are used to bring propulsion systems and the test facility complexes from ambient temperatures to several hundred degrees Fahrenheit below zero. This chilldown represents a high loss of energy that cost millions of dollars. Research into operations techniques, recovery facilities and equipment, and energy management and conservation, could likely improve ground testing to save money and energy.

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Advanced Propulsion Systems Testing — Innovative techniques will be required to test propulsion systems such as advanced chemical engines, single-stage-to-orbit rocket plane components, nuclear thermal, nuclear electric, and hybrids rockets. With a shrinking budget and longer leadtimes to develop new propulsion systems, new approaches must be developed to test future propulsion systems. The solution may be some combination of computational-analytical technique, advanced sensors and instrumentation, predictive methodologies, and possibly subscale tests of aspects of the proposed technology.

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TECHNOLOGY TRANSFER

Use of Visualization Technologies for SSC Data Analysis — This research will consist of a review of current visualization software packages (i.e., AVS). Assessing the feasibility of using these packages for developing interface and file format standards for use across SSC programs in order to share resources, data, techniques and technologies. Various SSC programs/activities such as E-1 (component test facility), New Launch System (NLS), center archival, and propulsion testing, require a “visualization” function for data analysis and display. A feasibility demonstration will be developed using an actual application, thus allowing the visualization technology to be used across multiple SSC programs.

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Image Compression — This research will involve an investigation into current technology for performing image compression on both static and animated imagery. Applications will be for a broad range of data utilized at SSC including satellite, airborne scanner, video, medical, and multimedia. Focus will be on the reduction of physical media required for storage as well as reduction of time for network transmission of data. Issues will include compression ratios, data fidelity, and speed of compression/decompression algorithms. A recommendation and demonstration of a compression technique for each of the imagery types included in the study will be required.

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EARTH OBSERVATIONS RESEARCH

Remote Sensing and Plant Physiological Ecology — The detection of plant radiative responses to growth conditions remains as a major goal in remote sensing research. This is true particularly with respect to early detection of plant stress. We are interested in the continued study of leaf and canopy reflectance responses to various stress agents, and the development of techniques to enable the earliest possible detection of stress. This has involved the identification of narrow spectral bands in which reflectance is most strongly affected by various stress agents. We also are continually interested in basic influences on leaf radiative properties, and their relationships to leaf chemical content and physiological processes, particularly photosynthesis.

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Coastal Processes — Focuses on interdisciplinary research related to biogeochemical cycles (biological - physical interactions) and coupling between land and ocean processes. Work includes algorithm development and image processing across multiple computer platforms.

John C. Stennis Space Center

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Research Software — Emphasis on developing efficient software for the analysis and visualization of in situ and remotely sensed data for earth science research. Focus is on low-cost computer platforms.

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Archeological/Anthropological Predictive Modeling — Remotely sensed satellite and airborne data can be used to detect anomalies in the surface cover that are representative of prehistoric cultural remains. Sophisticated computer-analysis techniques have been developed to extract archeological/anthropological phenomena from the nonvisible portion of the electromagnetic spectrum. By combining remotely sensed and ancillary information into a data base, accurate predictive models can be developed to isolate potential locations of prehistoric activity. Various cultures representing diverse environmental conditions are being examined to determine the spectral and spatial characteristics required for archeological/anthropological features detection.

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Paleoeconological Research/ Human Adaptations — Focuses on the adaptation of human populations to coastal environments from prehistoric times to the present. Emphasizes interdisciplinary research to develop ecological baselines in coastal zones through the use of remotely sensed imagery, in situ field work and the modeling of human population dynamics. Utilizes cultural and biological data from dated archaeological sites to assess the subsistence and settlement patterns of different human societies in response to changing climatic and environmental conditions.

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COMMERCIALIZATION

Commercial Remote Sensing — The Commercial Remote Sensing Program is designed to establish US preeminence in value-added information products derived from remote sensing and related information technologies. The program is accomplished by conducting collaborative research in application and advanced technology development projects with private firms, universities, and government agencies focused on the following areas: 1) satellite data acquisition; 2) data analysis/product generation; and 3) information distribution and product delivery.

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